POWER

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ELY C. HUTCHINSON, *Editor*

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Machines and Men

THERE has been much criticism of late of this machinery age—of the reduction of the artisan to an automaton performing repetitive operations with no demand upon his craftsmanship or creative power. Instead of working in his vine-clad cottage on a sunlit hillside, and dancing on the village green, he is huddled into the tenements of a smoky, grimy factory town and becomes a cog in the industrial grind.

They say that we are making inventors, captains of industry, and multi-millionaires, but no Bacons, Newtons, Shakesperes, or Beethovens—that our effort is directed at the physical and material rather than the spiritual and intellectual side of man's development.

Don't let it worry you. There never was a time when more people had the time and the means and the facilities for absorbing the ideas of the world's great thinkers, for enjoying the beauties of literature and art than the present. The tenement or the factory town contains more of comfort and convenience and cultural facilities. Their tenants are not only better clothed and fed, but have access to more intellectual thought, impelling and soul-stirring stimulus, and more leisure to profit by it than ever any but the favored classes have had before.

We have conquered disease, pestilence and famine, reduced child mortality, increased the life expectancy of man and enlarged the radius of his existence and contact with life. The arduous physical brunt of the struggle of man with his environment has been transferred from human muscle to tireless and rapid machinery. The great ideal of universal well being has never been so near to realization.

F. R. Low

EDITORIALS

POWER was founded in November, 1884, by E. P. Harris and H. M. Swetland. With it was incorporated "Steam," which had been started by N. Hawkins in Chicago two years earlier.

Ownership later passed to H. M. Swetland and James H. McGraw; then to John A. Hill; and with the consolidation of the Hill and the McGraw publishing companies in 1917 it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of Power. Subsequent editors for short periods were George L. Fowler, A. D. Risteen, and Franklin VanWinkle. F. R. Low became editor in 1888.

The present staff is Ely C. Hutchinson, editor; F. R. Low, editor emeritus; A. D. Blake, managing editor; P. W. Swain, Thomas Wilson, F. A. Annett, and L. H. Morrison, associate editors; and A. L. Cole, R. B. Purdy, H. R. Clark, and L. E. Driscoll, assistant editors.

A New World Force

THE most significant, and the satisfying, thing about the Second Plenary Meeting of the World Power Conference at Berlin was the practically unanimous conception of its importance as a vehicle for the development of better understanding and lasting relationships between nations.

Here was no barrier of language nor difference in thinking. The language of the blueprint and of mathematics was universal. No interpreter was necessary in the common purpose of better utilization of the world's energy supply. All were of one mind in the desire to aid in the better dissemination of the benefits of power to all people.

The force of this will be felt by those to whom the destinies of nations are intrusted, and there must follow the clarification of those problems of government, of commercial conflict, of international adjustment, which will result in everlasting benefit to humanity.

The immediate benefit from the reading and discussion of the papers is recognized; but the underlying possibilities are transcending.—E. C. H. (FROM BERLIN).

Train the Engineer in Accident Prevention

ONE of the large items of waste in industry is that caused by injury to workers. In industry alone approximately three million persons are injured annually in accidents entailing the loss of one or more days.

These cause an annual loss of over eight hundred million dollars in wages, and cost employers in compensation and doctors' bills nearly two hundred million dollars. In addition there is a large loss to the employer resulting from decreased production, increased labor turnover, lower morale, material spoilage, and property damage.

These losses were emphasized in a paper, "Should Colleges and Universities Create a Safety Engineering Course," by J. A. Voss, presented at the recent convention of the Association of Iron and Steel Electrical Engineers. Aside from humanitarian considerations, which should always have first place in accident prevention, safety engineering has tremendous economic possibilities that no employer can afford to neglect.

There could be no more fitting task for our universities and colleges than using their facilities to help relieve industry of the heavy toll caused by accidents. Design and operation of plants are becoming more and more the responsibility of engineering-school graduates. Making "safety first" a fundamental of good design as taught in engineering courses will do much to eliminate dangerous practices that now exist in industry. Some of the engineering schools are giving safety a place in the curriculum, but the job cannot be properly done until accident prevention is a part of every engineering course.

The Last Frontier of Energy

LAST WEEK, at the World Power Conference, Prof. A. E. Eddington, distinguished British scientist, offered new hope that man may some day tap the inexhaustible stores of sub-atomic energy. When that day arrives, said Professor Eddington, a teacupful of water will provide energy enough to operate a 100,000-kw. plant for a year. The prospect intrigues the imagination, although he did not suggest that the coal business is in any immediate danger.

Coal can, and probably will, supply our principal energy needs for some generations. Yet sun, wind, waves, and tides are definitely usable as power sources. When approaching exhaustion of coal makes it necessary, some or all of these may be utilized if no key is found to unlock the storehouse of sub-atomic energy.

Scientists who, like Millikan in America and Eddington in England, have the supreme gift of making themselves understood by intelligent laymen, perform a double service. In their own generation they expand the horizons of millions who follow their words. And future generations will enjoy the engineering achievements made possible by the scientific foundation they lay.

Should Machinery Be Built to Last?

FREQUENTLY a machine salesman, to clinch his argument, declares his equipment is built to last a life-time. That power plant machinery will and does last a life-time is evidenced every day by corliss engines that though built in the eighties are still pounding away. Equally long-lived are many boilers, pumps, and internal-combustion engines, which frequently serve two or three generations of owners.

But the question arises: Is long life built into a machine at the expense of first cost justified?

Long life was an essential machine characteristic a decade ago, but management has discovered that in many industries advances in design are so rapid that the useful life is far less than the actual machine life, so that obsolescence is given the consideration formerly devoted to depreciation or wear and tear. There has, as a consequence, come into existence a widespread practice of expecting a machine to earn its investment costs within three or four years, thereby affording protection against early obsolescence.

If the purchasers use the useful rather than the actual life as a factor, are not machinery builders making a serious error in attempting to build long life into their product? If the buyer bases his determination of machine value upon the assumption that the machine will become obsolete in five years, is it not an economic loss to incorporate in the design expensive elements that will insure a working life of twenty years?

Today most ammonia compressors, for example, are of the ponderous, slow-speed type. If manufacturing costs are seriously influenced by machine weight and speed, is it not more logical to build high-speed lightweight compressors? With a five-year life satisfactory to the purchaser, a compressor similar to the automobile gas engine seems to possess the merit of cheapness in production. The same reasoning seems to dictate a general advance in speed for all power plants.

A manufacturer may obtain great personal satisfaction in the long life of his engines that have operated for twenty years. But the buyer as well as youth must be served—and he seems to be satisfied with a short machine life if it reduces first costs.

High Economy From Mercury Vapor

IMPROVEMENT in thermal economy in any heat-power process demands an extension of the temperature range of the working substance. Superheated steam at moderate pressures has the disadvantage that most of the heat is received by the steam at a temperature well below the maximum, so that the mean effective temperature is considerably below the maximum. The energy available for the conversion into work is thus not so high as might be expected. By using mercury as the working medium this disadvantage of steam is largely overcome, the saturation temperature corresponding to 70 lb. gage being about 880 deg. F., while the highest saturation temperature procurable with steam is 706 deg.

The economies actually obtainable by using mercury in a binary-vapor system are indicated by the operating results secured by the Hartford Electric Light Company at its South Meadow station and reported in this number. For four months this unit has produced a kilowatt-hour on an average of 10,200 B.t.u., thus establishing a new record of fuel economy. Preliminary difficulties with boiler and turbine, which kept the unit out of operation for a considerable period, now appear to have been overcome to the satisfaction of the engineers in charge, and great credit is due to them for the pioneer work that has been accomplished.

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POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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Mercury Vapor Unit

Operates Successfully

By JAMES ORR
Superintendent of Power
Hartford Electric Light Company

It is now in regular operation at the plant of the Hartford Electric Light Company, taking its daily share of the load. Experience and results obtained in the operation of this equipment since it went into service are related in this article. With mercury vapor at 880 deg. F. this installation is operating at temperatures higher than in any other power plant in the United States.

THE mercury vapor process represents the idea and efforts of W. L. R. Emmet, consulting engineer, of the General Electric Company, to increase the upper working temperature range of prime movers by using mercury as a heat-transmitting medium in the upper ranges because of its stable characteristics at high temperatures, and also because it condenses at a temperature well above the saturation temperature of the prospective practical working pressures of steam.

Our experience with the mercury apparatus dates from 1922, when, through an agreement between the executives of the Hartford Electric Light Company and the General Electric Company, it was decided to install a unit intended for the commercial generation of electrical energy at the Dutch Point plant. It was the understanding that the equipment would be subject to many changes and have to pass through an indefinite period of development before being considered as generating capacity.

The first mercury boiler installed at Dutch Point was a fire-tube type and had the appearance of a honeycomb in which the center cell of each group of seven was sealed at the end.

The boiler was like a disk, 12 ft. 8 in. in diameter x 4 ft. 7½ in. high, and was built up of hexagonal tubes welded along the edges, allowing a space for the mercury between. The circulation was down through the center sealed-over cell and up the spaces between the six tubes surrounding it. This boiler was not a success structurally but it did demonstrate the feasibility of the process and generated the equivalent of 6,052,000 kw.-hr. It was replaced by one of water-tube design.

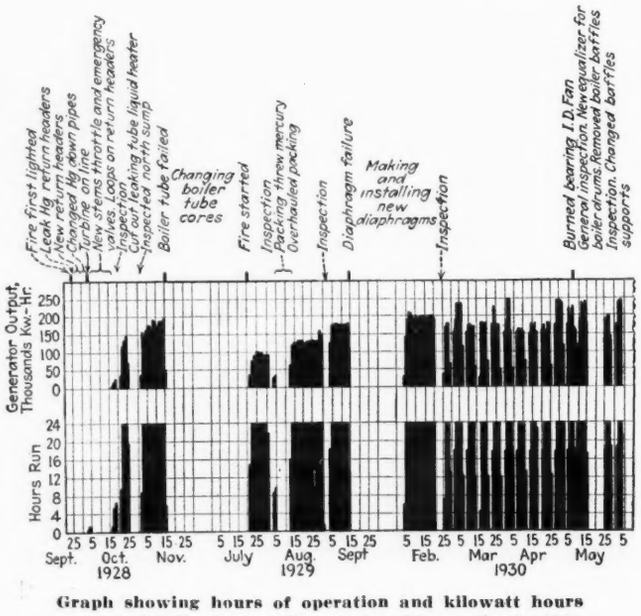
The second boiler was made in sections, each section being a unit in itself, consisting of a rectangular box in plan cross-section 14 ft. long by 1 ft. 1 in. wide. Vertically the cross-section of the box was in the form of an elongated and inverted "U"—3 ft. high, with the flat sides supported by stay bolts. Into the bottom part of the "U" were welded 160 tubes 3 in. in diameter x 5 ft. long having an inner hollow core after the order of the first experimental boiler. They were arranged in stagger formation projecting down into the furnace from the bottom of the "U," or tube sheet. The sections, four in number, were placed about 3 in. apart.

This boiler worked well for some time, but leakage took place at the stay bolts which supported the flat surfaces, and where the side sheets and the ends were welded together. The tubes also began to leak at the bottom.

Many changes were made in other parts of the unit, but fundamentally the entire process remained the same. Failures in operation were always due to poor workmanship or to faulty mechanical design for meeting some natural physical law, such as expansion. From the data collected while this unit was in service our executives felt that they were justified in recommending the installation of a larger unit at South Meadow where, due to its increased size and more efficient use of the steam produced, it would be of greater value to the company.

The South Meadow[1] unit, like its predecessors, is a complete power plant in itself, generating 10,000 kw. in a turbine generator driven by the mercury vapor, and 129,000 lb. of steam per hour at 280-lb. pressure as a by-product, which is delivered to the steam mains for use in the steam-driven turbine generators.

The mercury boiler is composed of seven forged-steel drums 21 ft. 6 in. long x 37 in. outside and 30 in. inside



Graph showing hours of operation and kilowatt hours generated daily since unit was placed in service in 1928

[1]See *Power*, May 31, 1927, p. 818.

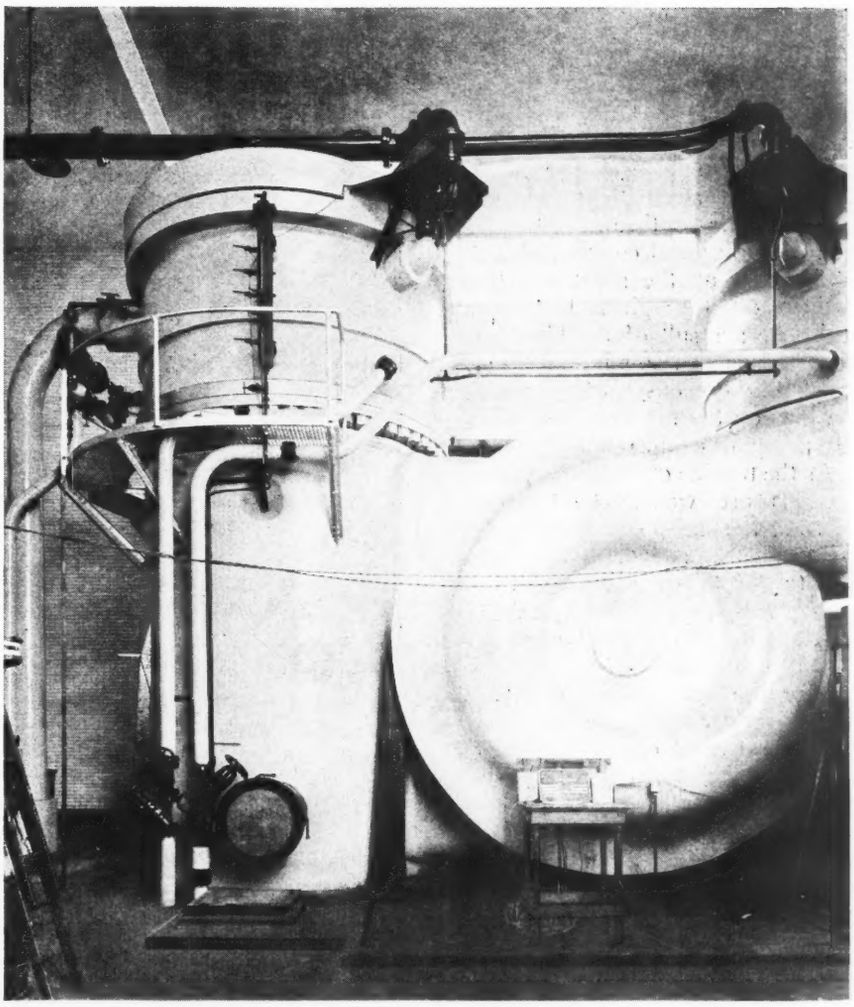
at South Meadow

diameter. The drums are suspended on hangers from outside the boiler setting, and into each drum are welded 440 dead-ended tubes 5 ft. 6 in. long x $3\frac{1}{8}$ in. outside diameter, with a hollow core insert about $\frac{1}{4}$ in. smaller in diameter than the inside diameter of the tube. The tubes are made of low-carbon steel calorized on the outside as a protection against oxidation.

The core itself is made up of two tubes, the center one $\frac{5}{8}$ in. inside diameter and the outer about $2\frac{7}{8}$ in. with caps welded into both ends sealing over the space between the inner and outer tubes. This construction is to cut down the amount of mercury required.

On the outside of the core are button-like projections which fit the inside of the tube, thus centering the core in the tube and forming a definite space between the tube and the core for mercury or liquid-vapor mixture.

In the drums provision is made for circulation by placing a series of circular baffles on the bottom third of the drum with a space between the drum and baffle for liquid and vapor. Holes are drilled through the baffles opposite the centers of the cores, and into these holes nipples are expanded which project down into the cores, providing a positive feed for the $\frac{5}{8}$-in. down tubes. The circulation, due to the outside of the tubes being exposed to the furnace, is down through the center of the core and up between the core and the tube, then into the drum and up through the space between the baffles and the drum to the liquid level, where vapor is released and the liquid remaining returned to the beginning of the cycle.



This is the high-pressure end of the turbine with the condenser-boilers shown at each side. The unit has only two bearings, the turbine shaft being overhung from the generator bearings.

On top of the baffles, or nozzle plates, solid cast-iron pillows fill the space from about one inch above the baffles up to or slightly above the liquid level in the drums. They take up space that would otherwise be filled with mercury, a more expensive as well as a much heavier material.

The turbine generator is a 10,000-kw., 5-stage, two-bearing unit designed to operate at 720 r.p.m., 3-phase, 60-cycle, 11,000-volt. The low speed of the unit is due to the low nozzle velocity of mercury vapor; it being in the neighborhood of only one-third that of steam. All turbine dimensions are large; the fifth stage wheel is 11 ft. in diameter at the shroud ring, and the buckets are 27 in. long, with a wheel thickness at the hub of 7 in. All wheel clearances are relatively large, that for the 5th-stage wheel being over 0.9 inch.

Assembly of the turbine is unique in that there are no bearings—the turbine shaft being overhung from the generator bearing. Turbine and exhaust casing is one-

piece branching to two exhaust openings, one on each side, which serve to lead the exhaust vapors to the two condenser-boilers.

With the shaft and shaft packing in place with respect to the casing, the turbine assembly is a progressive operation, as the fifth-stage wheel must be placed first, then the fifth-stage diaphragm; next the fourth-stage wheel, followed by its diaphragm, etc., to the first-stage wheel, which is the last to be put on. When the wheels are all in place and the diaphragms securely bolted together and to the exhaust casing, the turbine casing head, which includes in it the primary nozzles and the vapor chest, is bolted and welded to the casing. The advantage of this type of construction lies in the fact that there is only one shaft seal, and that against vacuum, eliminating all possibility of mercury vapor contamination of the surrounding air.

The shaft packing on the turbine is of the water-seal type, sealing against the vacuum in the exhaust casing. Water is admitted to an outer compartment. Leakage from this compartment, past a rubber diaphragm held tightly in place by the vacuum, is thrown to the outside of the second compartment by an impeller on the shaft and then drained off through a barometric seal. As a result of the high temperatures some water is evaporated, which has the effect of increasing the load on the non-condensible vapor pumping equipment.

As the turbine casing exhaust connections are welded to the condensers, a special construction for the condenser supports was necessary to maintain alignment of wheel casing with the turbine wheels, as they are in a fixed position on the generator shaft.

This was accomplished by welding heavy brackets at three points on the circumference of each condenser in line with the center of the wheel shaft. These brackets rest on supporting columns, which project up from the building steel. Thus the condensers are free to expand up or down from the center line and laterally, in pendulum fashion. The wheel casing, too, can move up and down from the center line. But in order to hold the wheel casing in the center line laterally a lug is welded on the bottom of the casing. It fits into a slot directly in line with the turbine shaft. This slot arrangement, secured to the building steel, holds the wheel casing in alignment with the shaft.

The mercury condenser is essentially a boiler and a condenser, since it functions as both. It generates steam at a pressure which has a definite relation to the vacuum temperature on the mercury turbine.

The condenser boilers, of which there are two, consist of a cylindrical shell in two parts, placed vertically. The upper part is built to withstand steam pressure, and the lower part for vacuum. The vacuum section is welded to the lower head, or tube sheet, of the steam section, and into the tube sheet are welded 559 dead-ended tubes 3 in. in diameter. These project 14 ft. down into the vacuum chamber. A piece of thin steel extending nearly to the bottom is inserted in each tube to assist circulation.

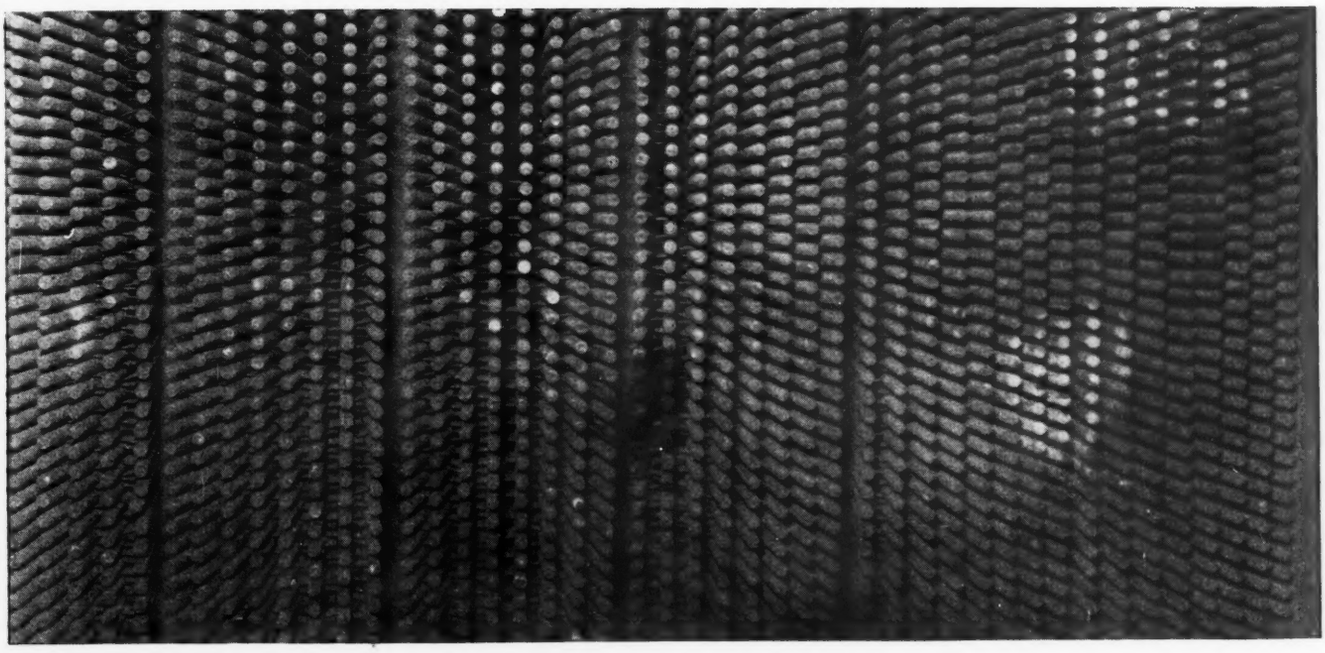
One condenser boiler shell receives the discharge from the mercury system safety valves, and the other has an atmospheric connection discharging into the flue gas passage. If abnormal pressure builds up in the vacuum space as a result of a steam boiler tube failure or because of lack of water in the boiler, the sheet packing, which acts as the seal for the atmospheric relief, blows out and relieves the pressure.

A liquid heater, or mercury economizer section in the gas pass directly above the mercury boiler serves to heat the liquid returning from the sumps to near the boiling point before it discharges into the boiler drums. Heater elements are built in two banks, each bank containing seven sections of 121 one-quarter inch tubes.

The boiler is fired by pulverized coal from three unit mills. The furnace is air-cooled, constructed of sectional cast-iron wall boxes which surround it and extend from a point about 5 ft. below the boiler tubes well down into the ash hopper, a distance of 30 ft. These boxes are protected by refractory tile fastened to them and are connected at their tops and bottoms with the circulating air system for combustion. They receive air at the top after it has passed through a tube preheater, and discharge it at the bottom, where it is distributed, part going to the pulverizers and part to the burner box. By this arrangement the furnace linings are protected and the air for combustion heated to 420 degrees.

Through the space left by the setting, which has been removed, the tubes can be seen projecting into the furnace from the drums

Relatively small quantities of mercury represent a considerable amount of money and, neglecting the toxic effect of the vapors, this would be reason enough for wishing to detect even the slightest leakage. A detector, using selenium sulphide, was produced by the research department of the General Electric Company. The device consists of a paper ribbon coated with the selenium sulphide and wound on a spool from which it is drawn over an aperature. Through this aperature a sample of flue gas or air is projected by a small fan. If mercury vapor is present the yellow selenium sulphide turns dark. The degree of discoloration depends on the time of exposure and the amount of mercury vapor in the mixture.



Looking up at the boiler it appears like a huge course brush

A color chart has been made up, which indicates the concentrations, or amount of mercury in the mixtures, that correspond to certain time exposures.

While the mechanical development of the process was going on the health of the men performing the work demanded a great deal of attention, on account of the poisonous nature of mercury and its vapor. Much was learned that led to the adoption of working rules for all men who had to come in contact either with the mercury or with parts of the equipment through which it had circulated.

Men who had to work on the mercury equipment were supplied with overalls, which were washed and cleaned frequently in the plant. In handling mercury, or parts which had been in contact with it, rubber and leather gloves were furnished, as mercury will penetrate the skin and cause poisoning after a time. Face masks were used where there was a possibility of the air being contaminated by mercury vapor, and when work had to be done inside the boiler drums, masks with an outside air supply were worn. That made it safe to stay inside the drums indefinitely.

During the early stages of the development, when a large amount of work had to be done where there were fairly high concentrations of mercury vapor in the air, we had some men with symptoms of poisoning, but there was not a single serious case. These cases led the way to the adoption of preventive measures, and we now feel that any kind of work can be done with perfect safety. So far as the actual operation of the unit is concerned, there is no more risk to the men than they would encounter operating steam equipment.

In connection with the development work on the unit at South Meadow there were two failures that kept the mercury unit out of service for a long time. One was on the boiler and the other on the turbine.

The boiler failure was the result of a misfit tube core which got out of center in the tube and so restricted the flow of the rising vapor that the tube became overheated, and a hole was burned on one side through which the mercury leaked into the furnace. The leakage, although slight at first, was indicated on the mercury vapor detector that is connected to the smoke stack. The operators, on seeing evidence of leakage, stopped the pulverizers and shut down the unit.

As a result of the failure of this tube and evidence of burning on other tubes it was decided to remove all the tube cores. The design was corrected and new cores installed that would eliminate the possibility of a recurrence of this kind. The new cores, instead of being in one piece the full length of the tubes, had to be put in the tubes in sections in order that the assembly could be made from the inside of the 30-in. drums. Several types of cores were tried out. The core shown in the tube cross-section was adopted and meets all the requirements.

The trouble in the turbine that caused it to be shut down was indicated by a rubbing inside the wheel casing: the result of distorted diaphragms and cracked diaphragm nozzles due to lack of strength and proper support in the casing.

This failure was somewhat unexpected in view of the experience gained at Dutch Point, for while that machine was smaller and only a three-stage unit it was subject to practically the same conditions.

However, the General Electric engineers decided that making the unit safe was only a matter of using heavier construction on the diaphragms and nozzles and securing the diaphragms more rigidly to the casing. Several months was required to design the new diaphragms and make patterns and castings.

At a recent inspection of the turbine everything was found to be in perfect condition, and the unit was put back in service without any changes having been made.

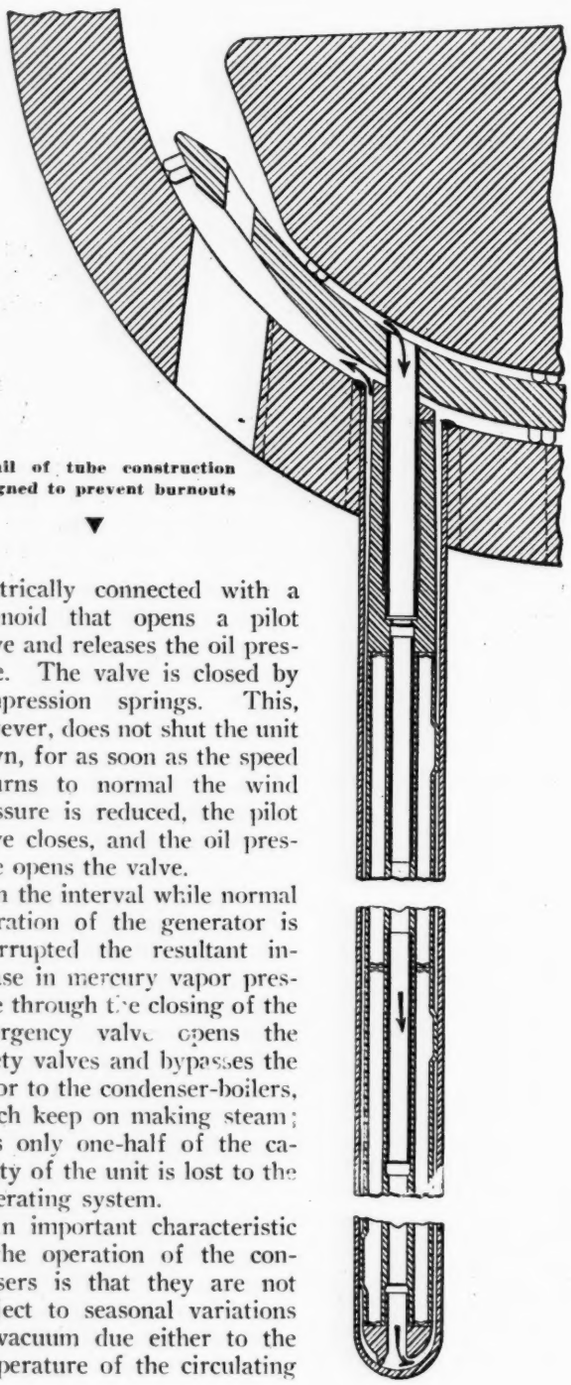
Operation of the unit since Feb. 4, when it was put in service after the reconstruction of the turbine, has been very satisfactory. It has been shut down Sundays in order to use surplus water power which would have otherwise gone to waste.

Starting the unit is extremely simple, as there are no valves on the mercury cycle other than those on the turbine room floor. These consist of a throttle valve, an emergency valve and two safety valves. The latter bypass

the vapor into the condenser-boiler vapor space in the event of excess pressure on the mercury boiler.

The fire is started in the usual manner for bringing up a pulverized-coal boiler, and when the vapor pressure begins to build up the throttle is partly opened admitting enough vapor to the condenser-boiler to build up steam pressure, but not enough to start the turbine. This equalizes the temperatures throughout the entire structure with a resultant uniform expansion, after which the turbine can be started. In cutting the generator in on the line the synchronizing is accomplished by throttling at the turbine. Loading of the unit is controlled by the fireman.

An emergency valve of spring-loaded construction operates by oil pressure, which is controlled, in turn, by the wind pressure in the generator casing. In case of overspeed the wind pressure is raised and acts on a disk



Detail of tube construction designed to prevent burnouts

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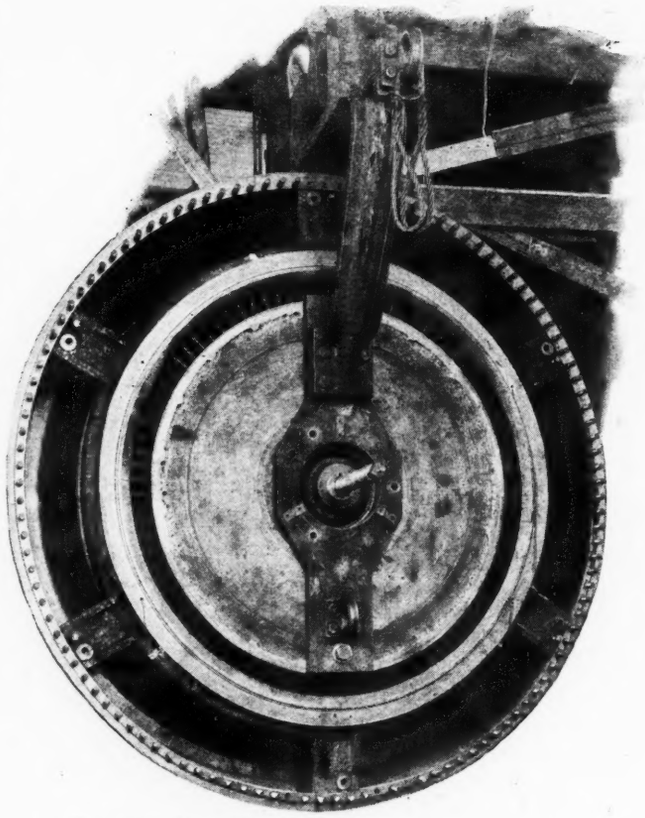
electrically connected with a solenoid that opens a pilot valve and releases the oil pressure. The valve is closed by compression springs. This, however, does not shut the unit down, for as soon as the speed returns to normal the wind pressure is reduced, the pilot valve closes, and the oil pressure opens the valve.

In the interval while normal operation of the generator is interrupted the resultant increase in mercury vapor pressure through the closing of the emergency valve opens the safety valves and bypasses the vapor to the condenser-boilers, which keep on making steam; thus only one-half of the capacity of the unit is lost to the generating system.

An important characteristic in the operation of the condensers is that they are not subject to seasonal variations of vacuum due either to the temperature of the circulating



To assemble the turbine, wheels and diaphrams must be put in place progressively

water or to fouling of the tubes. The steam boiler pressure fixes the back pressure on the turbine at all times.

There are no bolted or packed joints in the mercury cycle; all are welded; therefore, the only place that air can get into the condensers is through the shaft packing. As a result, when once the air has been removed from the mercury inclosure in starting the unit only a small vacuum pump is required to maintain a maximum vacuum, as there are no non-condensible vapors in the mercury. As further evidence of the stability of the mercury in the system, practically no impurities have been found in the cleaning sumps during inspections.

The daily operating records show the approximate value of the process to the power industry:

Capacity from mercury turbo-generator, kw.	10,000
Steam produced from condensers per hour, lb.	129,000
Av. steam temperature leaving superheater, deg. F.	735
Av. steam pressure in boiler drum, lb. ga.	280
Av. feed-water temp. to economizer, deg. F.	214
Av. temperature water to boiler, deg. F.	275
Mercury vapor pressure at throttle, lb. ga.	70
Mercury vapor temperature at throttle, deg. F.	880
Mercury vacuum temperature, deg. F.	445
Vacuum in mercury condenser, in. Hg.	28.25
Coal burned per hour, lb.	15,800
Heat in coal as fired, B.t.u. per lb.	14,300
Temperature of air at burner box, deg. F.	460
Temperature of gas to stack, deg. F.	335
CO_2 in flue gases, per cent	14.0

The performance from the start on Feb. 4 to June 4, 1930, inclusive, follows:

Coal burned, lb.	26,377,910
Water evaporated, lb.	216,670,000
Output mercury turbine generator, kw.-hr.	16,083,000
Equivalent output from steam, kw.-hr.	21,550,060
Total station service, kw.-hr.	721,130
Total net output, kw.-hr.	36,911,930
Coal rate on total net output, lb. per kw.-hr.	0.7146
Hours in service	2,032

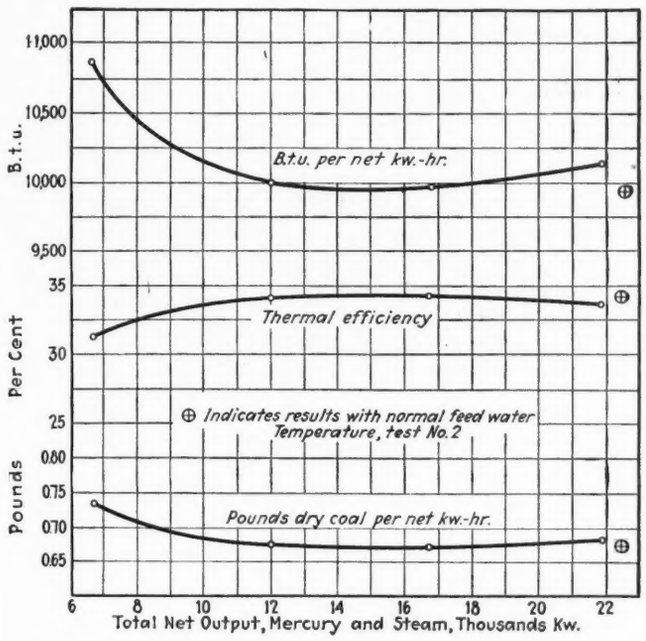
The unit is operated as a part of the plant generating equipment, taking its load variations to meet the system demands, operating on loads as low as 1,500 kw. during

the early morning hours and shut down regularly on week-ends, when the hydro plants could carry the load at a saving.

The average coal rate can be so improved by operating the unit on a base load that a kilowatt-hour on the station bus can be generated for less than 10,000 B.t.u. Actual operation over a period of several days, with a steady load of 9,500 kw. on the mercury turbine generator resulted in an average rate of 9,800 B.t.u. per kw.-hr. net.

It is believed that maintenance costs will be less than for a straight steam station. The following characteristics will serve to make this clear:

There should be little maintenance required on the mercury boiler. Once it is sealed up it need not be



Combined test results of generation by mercury unit direct and by steam produced, assuming steam utilization at the rate of 10 lb. per net kw.-hr.

opened again, as internal cleaning is not required. There can be no scale deposit, no corrosion or pitting. There will be no tube failures due to scale formation, and feed treatment is not required. The external cleaning is easy, as the tubes are short and in practically a vertical position. The furnace maintenance should be the same as for any pulverized-coal-fired steam boiler.

The return of mercury to the boiler by gravity eliminates boiler feed pumps, valves, and regulators, and their accompanying maintenance.

The turbine should easily be taken care of, as there are only five stages. It being a two-bearing machine, there is less to maintain. Should the bearings fail the wheels would not be damaged, on account of the large clearance, nor would the diaphragm packing be hurt, as it is of the floating type and would accommodate a considerable amount of wear in the bearings.

Considering the condenser: Tube failures caused by erosion, corrosion or electrolysis are not expected. It is unnecessary to clean tubes to maintain a reasonable vacuum, and as a result of the mercury vapor generating half of the station output, the circulating water requirements are reduced by half, with a corresponding reduction in the intake and discharge tunnel and water screening equipment sizes.

Regarding the condenser as a boiler: There is no burning or distorting of tubes as in a boiler with a fire under it. No hard scale can be formed in the tubes, because of the comparatively low temperatures of the mercury vapor in the condenser and the vigorous circulation in the tubes. Irrespective of the amount of scale-forming solids in the feed water, it will require less care than an ordinary steam boiler.

From the foregoing it can readily be seen that the mercury vapor unit has a wide field of application with economic results close to the theoretical and beyond that of anything yet achieved.

It has not given evidence that would lead us to have less confidence in it than in steam equipment. Because simplicity of equipment plays such a large part in dependability, the mercury plant will be more reliable than many steam plants, where refinements have introduced undesirable complications.

As mercury does not attack steel, it has not been found necessary to use any special materials in construction. While the temperatures of the mercury are fairly high, the pressures are low, thus permitting of the use of light-weight containers.

Test on Climax Distillate Engine Made at Armour Institute

TESTS of the new 6x7 four-cylinder "Blue Streak" model distillate-burning carburetor engines manufactured by the Climax Engineering Company, Clinton, Iowa, were made recently by the engineering staff of the Armour Institute, Chicago.

Furnace oil made by the Standard Oil Company of Indiana was used in the test, power being reported without corrections for barometric or temperature conditions. The following table of power and economy obtained was submitted by engineers in charge of the test:

R.p.m.	Brake M.e.p.	Brake Horsepower	Fuel, Lb. per B. Hp.-Hr.
595	98.3	58.5	.753
606	97.8	59.1	.750
625	97.7	61.0	.733
766	97.5	74.8	.703
886	95.0	84.3	.692
1,009	92.0	92.7	.677
1,015	91.5	92.8	.677

In a fractional distillation of the furnace oil, the first drop came over at 376 deg. F., 80 per cent before 450 deg. was reached, and 99 per cent was distilled when 519 deg. was reached.

The gravity was 38.2 deg. A.P.I. at 60 deg. F., and the cost, in 100-gal. lots, was 8 cents per gallon.

Average results show that the 6x7 four-cylinder model will develop 85 to 92 hp. at approximately 1,000 r.p.m., depending on barometric conditions and the amount of heat used in the intake manifold. Flexibility requirements, as well as power output, were satisfactory in each instance. One phase of the test showed that this engine easily delivered 90 hp. at 1,000 r.p.m. with a fuel rate of 0.7 lb. or lower when operating under average conditions.

When gasoline was substituted for the distillate, the hot air pipe was removed and the carburetor readjusted for economy. At 1,016 r.p.m. 91.6 b.hp. was developed with a fuel consumption of 0.587 lb. per brake horsepower-hour. This was secured with the special low-compression heads used for the distillate operation.

STEAM AND HYDRO

Featured in Closing

The Second World Power Conference opened in Berlin on Monday, June 16, and completed its formal sessions on June 25. This article concludes the report of a meeting that has made power history

NEVER have engineering meetings been more fruitful than the sessions of the Second World Power Conference, which completed its monumental program on Wednesday, June 25. Staged in Berlin, capitol of a great industrial nation, attended by leading power engineers from many countries, and nourished by the world's best engineering and economic thought, the conference has definitely contributed to the progress of a civilization based on machines and energy.

Twelve pages of the preceding number of *Power* outlined the first week's proceedings and gave the essence of many important papers presented.

The concluding sessions on Monday, Tuesday and Wednesday of the second week, here reported, were of especial interest to *Power* readers.

In particular, the meetings dealing with steam engines and turbines, water power, boilers and furnaces, and combined heat and power plants were notable for the large number of important papers presented, many of them by American engineers.

As in the previous week, when Einstein and other distinguished men addressed the conference, meetings of general interest were held in addition to the specialized sessions. On Monday Prof. A. E. Eddington, distinguished British scientist, spoke on sub-atomic energy. He predicted that the same abundant energy which heats the sun and the stars may one day be put to the use of mankind.

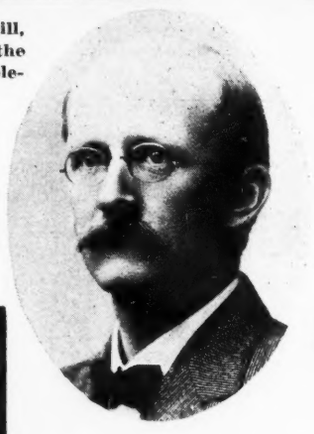
Envisioning a day when present fuel arrangements will no longer be needed, he said that instead of "pampering the appetite of our engine with delicacies like coal and oil, we shall induce it to work on a plain diet of sub-atomic energy. If that day ever arrives the barges, trucks and cranes will disappear and a year's supply of fuel for a large station—namely, 30 grams of water—will be carried in a teacup or anything else that is handy."

At the same time he warned his listeners of the eventual "suicide" of the universe, asserting that unless "we can circumvent the second law of thermodynamics—which is as much as to say that unless we can make time run backward—the universe must ultimately reach a state of uniform changelessness."

The general address on Tuesday was delivered by D. N. Dunlop, chairman of the international executive council, who spoke on "Power and Civilization."

O. C. Merrill, Chairman of the American Delegation

Conrad Matschoss, Director of Germany's V.D.I.



George A. Orrok's paper dealt with high pressures

Research was C. F. Hirshfeld's subject (first week)

Sessions of WORLD POWER CONFERENCE

By ELY C. HUTCHINSON
Editor of POWER

The International Executive Council, World Power Conference, met in this impressive conference room of the "V.D.I. Haus"

A significant development not on the program was the merging of the International Dams Commission with the World Power Conference as a sub-committee organized to promote safety in the design and construction of large dams.

Commending this affiliation, the writer stated his conviction that: "A non-political, completely technical organization such as the World Power Conference is in a far better position than a governmental agency to supervise such matters. The work of this committee deserves support from engineers and should be followed closely. It has great possibilities for good."

Now that the Second World Power Conference has passed into history it is fitting to pause a moment to record a few impressions—both general and specific. The conference as an institution is less than six years old.

For the first plenary session in 1924 there came to London engineers, scientists, and economists from the four corners of the globe. The War which had left Europe prostrate in 1918 was still an active force in world politics. Yet former enemies met in friendly spirit to apply the principle of co-operation in the realm of constructive thought. Fittingly, the keynote of the London conference was a world power survey or inventory. Comprehensive papers listed in detail the power resources —fuel and water—of the various countries represented. In addition many papers dealt with utilization problems. It was decided at London to hold the plenary sessions at intervals of approximately five years with sectional meetings between.

Water power was the subject of discussion at Basle in 1926. At London in 1928 coal, gas, oil, and other fuels received consideration commensurate with their importanc in the modern world. Barcelona was the scene of the third sectional meeting in the spring of 1929. There water power was the subject, with emphasis on administrative features. Japan's growing significance in the power field became evident in papers presented at Tokyo last year.

Finally came 1930 and Berlin. In six years the power field, progressing rapidly, had set itself many new problems for consideration.

The decision of the German committee to make economics the keynote of the second plenary session was a master stroke. This more perhaps than any other single factor explains the general excellence of the papers presented and their fundamental importance.

All here have felt the influence of the atmosphere of the conference—the broadening touch of international fellowship, the contacts with great spirits of the age, such as Einstein, von Miller, and Eddington. They have enjoyed this friendly contact with a nation which so strangely combines remnants of medieval life with all that is most modern in science, industry, and art.

Certainly one may repeat, without fear of exaggeration, that this has been the greatest power conference in history, and in all probability the most productive engineering conference of any sort.

The conference, as already stated, officially disbanded after the Wednesday sessions. Excursions to many points of interest in industrial Germany were then made available. Seven different tours covered the following sections: Berlin and environs; industrial regions of the Rhine and Westphalia; through central Germany to Baden; Bavaria and the south; Silesia; Pomerenia; East Prussia and the Hanseatic region. These tours were filled with sights of ancient and modern Germany.

Following is a survey of papers of particular interest, presented in the concluding technical sessions:

Official U. S. Delegates en route to Berlin—Left to right: Robert Sibley, David B. Rushmore and Ely C. Hutchinson

A NEW BINARY CYCLE

A new binary cycle of very great scientific and practical interest was described by Dr. Ing. E. Koenemann (V.D.I.). The Koenemann process employs ammoniacates as a primary medium, from which the ammoniac vapor is expelled. In this process the ammoniac vapor is evolved by the decomposition of the ammoniacates, and is again recombined in its original form after having performed work. The advantages claimed for this process include the favorable properties of the media employed, which enables high initial temperatures, and consequently high thermal efficiencies, to be obtained without the necessity of employing special engineering materials.

Dr. Koenemann gave calculations comparing his system for initial pressure of 100 lb. in the ammoniac vapor stage and 295 lb. in the steam stage with a steam plant for 295 lb. pressure. The comparison showed a saving of fuel of 29½ per cent and a saving of cooling water of 41 per cent.

Of special interest was Dr. Koenemann's claim that installation costs would probably not exceed those for standard steam power plants. However, definite information on this point awaits completion of preliminary tests and construction of the first plant.

[An abstract of this paper will appear in a later number of *Power*.]

The International Executive Committee assembling at the "Ingenieur Haus" on the eve of the Conference

GAS TURBINES

The latest developments and the future prospects of large gas engines and gas turbines were discussed in a paper by Prof. P. Langer, of Germany. In his opinion, the problem of the gas turbine has been brought nearer to a solution by the Brown-Boveri waste gas turbine of the Büchi supercharging system for Diesel engines, and by Holzwarth's design of a new combined explosion gas turbine (for the high-pressure stage), and the constant-pressure gas turbine (for the low-pressure stage), in which waste heat is utilized. It was announced that a 2,000-kw. unit of this type is under construction at Brown-Boveri's Baden works, with an anticipated over-all efficiency equal to that of a large gas engine utilizing waste heat.

Prof. Langer pointed out that the total efficiency of the plant and the solution of the problem depends chiefly upon the efficiency of the steam turbine set, which is driven with waste steam and performs the work of compression.

"Normally," said Prof. Langer, "the steam generated in the water used to cool the combustion chamber goes to drive the steam turbine, which, in turn, compresses the combustion air for the gas turbine. If the available steam power from this source is more than is required for compression (as may occur if combustion is carried on with a minimum of excess air) it would be advisable

to couple a generator, as well as a compressor, to the steam turbine, thus gaining additional power for outside consumption."

HIGH-PRESSURE STEAM

Discussing the economics of high-pressure steam, George Orrok, New York City, consulting engineer, said: "It is fair to say that in the future high-pressure stations with large units will cost no more than standard stations, and that there will be little, if any, difference in fixed charges for any given use factor. Reports from all users of high-pressure apparatus agree that labor and maintenance costs are the same for both high- and low-pressure installations, and these comparisons are now possible over considerable periods of time and for a number of different conditions.

N. E. Funk (above) showed how hydro should work in harness with steam

William F. Ryan (below) pointed to industrial power economies

"Nine thousand B.t.u. per kilowatt-hour will probably be the absolute minimum to be secured from the high-pressure station. Taking our previous experience into consideration, it is unlikely that 10,000 B.t.u. will be exceeded, and present-day plants are within 20 to 25 per cent of this. The last increment must, of course, be had by careful design and construction, coupled with the best operation obtainable, and economical results predicate the largest use factor attainable and base-load operation with as few and as large units as may be available."

In his paper, Mr. Orrok stressed the importance of high use factor, and pointed out that stations operating at 400 to 600 lb. pressure may show better thermal economy than high-pressure stations when they operate at much better use factor. In addition, of course, high use factor greatly decreases the fixed charge cost of energy.

"No boiler with inside calking only has cracked," said F. D. Straub

The practical and economic results obtained with high-pressure reciprocating engines at the Vienna Locomotive Works were reported in a paper by Ing. A. Demmer, of Austria. Steam generated at 1,550 lb. and 890 deg. F. in a Loeffler boiler operating at 1,700 lb. pressure is reduced in a double-acting single-cylinder reciprocating steam engine. The steam then passes to a condensing engine. The back-pressure engine has a capacity of 450 kw. at 300 r.p.m. Herr Demmer stated that by foregoing complete expansion of the steam it has been possible to reduce considerably the weight of the driving gear of the back-pressure engine, in comparison with that of a condensing steam engine. "The results obtained in actual practice have," he stated, "been entirely satisfactory."

STEAM TURBINES

Prof. Dr. A. Stodola, author of a famous treatise on steam turbines, contributed an extensive paper on the technical development in Switzerland in the field of steam-power units. In the designs he showed were included many of great originality and interest, particularly in turbines. Among others, a cross-section was shown of a 4,000-kw. turbine designed to operate at 3,000 lb. pressure on steam generated by a Benson boiler.

Doctor Stodola felt that even for condensing units it would often pay to go to pressures of about 1,400 lb., while with back-pressure operations the advantage was even greater. "Much attention," he said, "has been paid by Swiss engineers to the prevention of premature wear by the use of suitable material for the blading, by taking proper precautions for the removal of water condensed in the last stages, by the avoidance of vibration danger and by making proper allowance for free expansion."

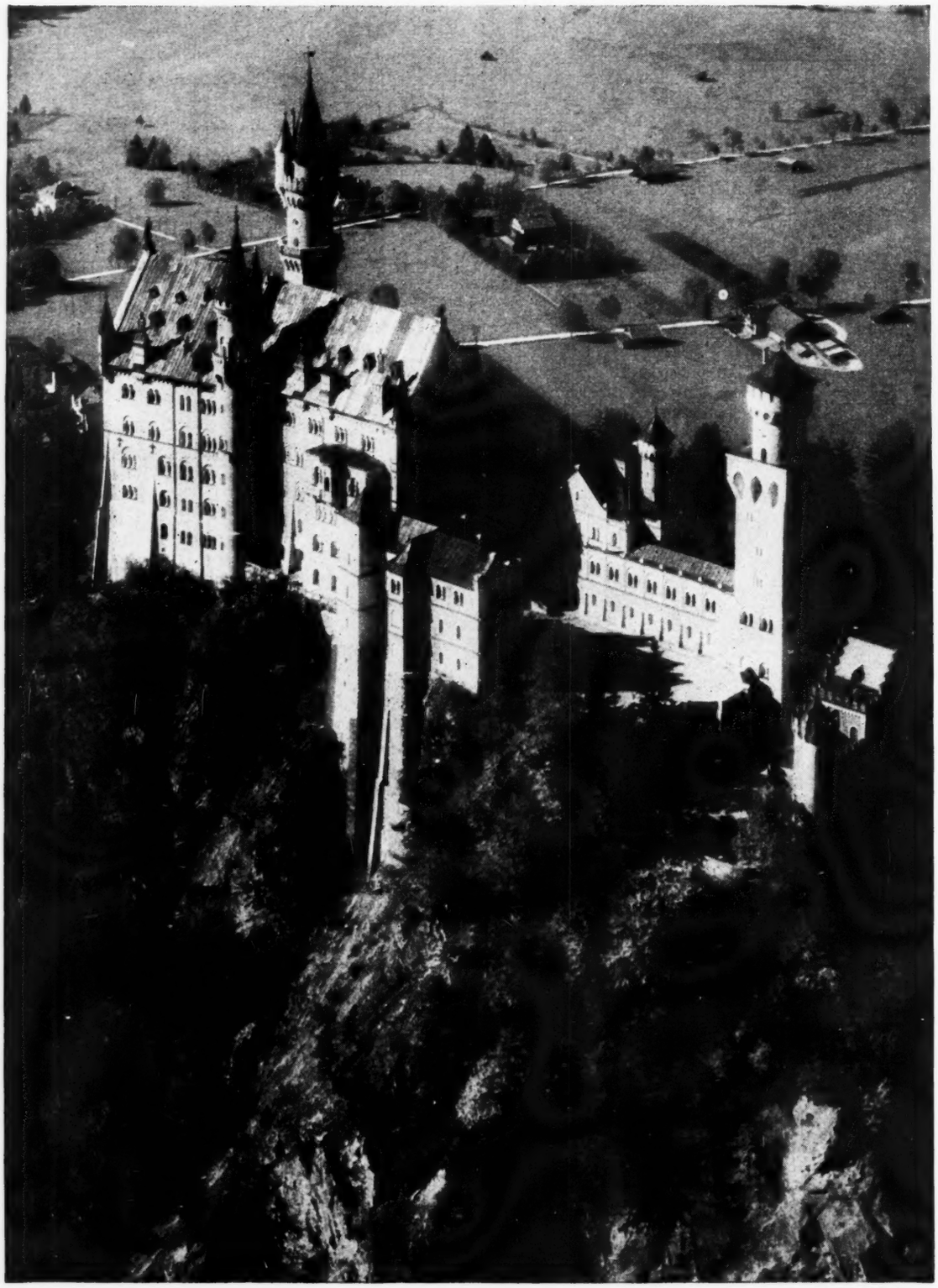
Under the title "Economic Considerations in the Application of Modern Steam Turbines to Power Generation" Prof. A. G. Christie (A.S.M.E.) discussed the turbine situation in the United States. An abstract of this paper will appear in an early number of *Power*. Of interest to mention here is Professor Christie's statement that turbine plants aggregating nearly 500,000 kw. are in operation or are under construction in America for pressures of 1,200 lb. and above. "Tests indicate," he said, "that in large turbine units the high-pressure cylinder using steam at 1,200 lb. pressure can be designed to give nearly as high efficiency as the low-pressure section, and that compound units can be built to give an over-all engine efficiency, based on kilowatt output, of 78 per cent.

In a companion paper to that of Professor Christie, G. B. Warren discussed recent and possible future developments affecting the economics of large steam turbine practice in the United States. This also will be abstracted later in *Power*. However, Mr. Warren's paper contained certain points of particular interest that should be mentioned here.

The most notable reduction in the cost of power, according to Mr. Warren, has been obtained by the use of larger units (turbines and boilers), resulting in lower first cost and better efficiency.

In conclusion, Mr. Warren predicted that the average capacity of turbines will continue to increase, and that the maximum size of single-shaft units may reach 200,000 kw. with hydrogen cooling. He also felt that the vertical-compound may become established.

With present temperature limitations, he felt that 2,500 lb. is nearly the economical limit of pressure, and said that with this pressure, 1,000 deg. temperature and six stages of feed heating without resuperheating, high efficiency might be combined with simplicity.



By Ewing Galloway

Medieval beauty in modern Germany—Neuschwanstein Castle in the foothills of the Bavarian Alps

WATER POWER

In the session on "Rationalization and the Technical and Economic Problems of Water-Power Utilization," T. H. Hogg (Canada) presented a paper on "Recent Trends in Water-Power Developments in Canada." He pointed to the enormous growth of water power there, the installed turbine capacity rising from 3,200,000 hp. in 1923 to 5,350,000 hp. at the end of 1928. New developments under construction at present, he said, will have an additional aggregate capacity in excess of 1,000,000 horsepower.

"Cheap power, such as abounds in Canada's water-power resources," declared Mr. Hogg, "is destined more than any other single contributary factor to lay the foundations of the country's future industrial growth."

He admitted, however, that as the more available sites were developed, the cost of new hydro developments would naturally increase and would result in increasing competition from steam plants. This realization has called into play a tremendous effort to offset, in whole or in part, the additional cost of these more expensive developments by devices to increase the efficiency of the component parts of the plant. Simultaneous efforts are being made to reduce first cost and cost of operation.

Simplified layouts, said Mr. Hogg, have become numerous, with the rejection of all but essentials; conservation of water is more carefully considered. Storage, together with reduction of leakage or diversion, is being carried to a further degree than ever before.

Simplification of generator design and an increasing use of outdoor transformer and switching stations are becoming evident, he said.

In connection with turbine design and construction, Mr. Hogg referred to the rapid development of the high-speed wheel, which is now dominating the low head field. This wheel has until recently been used in Canada with fixed vanes only, but there are indications that the movable-vane type, or Kaplan turbine, may be employed more widely for such installations.

Successful installations of propeller wheels have been made for operation under heads up to 60 ft., and it is predicted in some quarters that they will be built for successful operation up to 100-ft. heads.

In conclusion, Mr. Hogg predicted a considerable development in pumped storage for peak-load plants.

In a paper on technical and economical advances in the field of water power in Switzerland, Prof. E. Meyer-Peter and Prof. R. Dubs stated that experiences during the winter of 1928-1929 proved that difficulties due to the formation of ice are least in hydro-electric stations where conditions favor the formation of a sheet of ice at the surface.

B. E. White (U.S.A.) presented a paper on "New Developments in Regard to Economy, Utilization, and Extension of Water Power, Water Turbines and Pumps," which stressed the economic aspects of the problem. Mr. White proposed a method for studying the value and cost of a hydro-electric plant.

He would divide the cost into two elements: Capacity

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Technical Papers Mentioned in This Week's Report

(Arranged in order of sessions. General addresses, including remarks of Professor Eddington, are mentioned on page 11.)

SECTION 10—TURBINES AND ENGINES

DR.-ING. E. KOENEMANN (V.D.I.; Germany)—*"A New Binary Vapor Cycle"* (page 12).

PROF. DR. ING. E. A. KRAFT (Germany)—*"Most Recent Developments in Large Gas Engines and Turbines."*

G. A. ORROK (A.S.M.E.)—*"Economics of High Pressure Steam"* (page 13).

ING. A. DEMMER (Austrian National Committee)—*"Technical and Economic Results with High Pressure Reciprocating Engine in "Floridsdorf"* (page 13).

PROF. DR. A. STODOLA (Swiss National Committee)—*"Technical and Economic Advances in the Field of Steam Prime Movers in Switzerland"* (page 13).

PROF. A. G. CHRISTIE (A.S.M.E.)—*"Economic Considerations in the Application of Modern Steam Turbines to Power Generation"* (page 13).

G. B. WARREN (N.E.L.A.; U.S.A.)—*"Recent and Possible Future Developments Affecting the Economics of Large Steam Turbine Practice in the United States"* (page 13).

SECTION 13—PROBLEMS OF WATER POWER UTILIZATION

T. H. HOGG (Canadian Management Committee)—*"Recent Trends in Water Power Development in Canada"* (page 14).

BYRON E. WHITE (A.S.M.E., A.S.C.E. and N.E.L.A.)—*"New Developments in Regard to Economy, Utilization and Extension of Water Power, Water Turbines and Pumps"* (page 15).

SECTION 15—ECONOMIC PROBLEMS RELATIVE TO POWER STORAGE

ING. E. BODENSEHER and ING. R. GABLER (Austrian National Committee)—*"Pumped Storage in Connection with a Metropolitan Electrical Development"* (page 16).

N. FRENNE UND TH. STEIN (Swedish National Committee)—*"Experiences with the Ruths Accumulator"* (page 16).

SECTION 11—BOILERS AND FURNACES

FRED G. STRAUB (A.S.M.E.)—*"Intercrystalline Cracking in Steam Boilers"* (page 16).

H. W. BROOKS, E. G. BAILEY, W. L. MARTWICK, F. H. DANIELS, H. D. SAVAGE, T. H. BANFIELD (American Committee)—*"American Progress in Coal Firing of Boiler Furnaces"* (page 16).

E. G. BAILEY (A.S.M.E., N.E.L.A.)—*"Automatic Control of Boiler Plants"* (page 17).

E. R. FISH (A.S.M.E.)—*"Economic Development and Design of High Capacity Steam Boilers"* (page 17).

PROF. L. K. RAMZIN (State Thermo-Technical Institute; Russia)—*"Combustion of Fuel Fines in State of Suspension"; "The Chief Problems of Pulverized Fuel Combustion"; "Radiation in Boiler Plants"* pages 17 and 18).

SECTION 16—THE WATER POWER INDUSTRY IN INDIVIDUAL COUNTRIES

J. T. JOHNSON (Canadian Management Committee)—*"Water Power Resources of Canada and Their Development"* (page 19).

ING. ME. E. PIAGGIO (Argentine National Committee)—

SECTION 8—COMBINED HEAT AND POWER SUPPLY PLANTS

ING. A. DEMMER (Austrian National Committee)—*"The Economics of High Pressure Steam in Heat Work, Particularly for Distant Utilization Work"* (page 19).

W. F. RYAN (A.S.M.E.)—*"Combined Heat and Power Supply in Industrial Plants"* (page 20).

CH. W. E. CLARKE (A.S.M.E.)—*"Power Production in the Steel Industry"* (page 20).

B. F. WOOD (A.S.M.E.)—*"Engineering Aspects of Interchange of Power with Industrial Plants"* (page 20).

cost and energy cost. The former would be taken as the equivalent cost per kilowatt of an existing or proposed steam or other generating stations from which the same firm capacity might be obtained. The energy value would be obtained by multiplying the total usable kilowatt-hours obtainable per year from the hydro-electric plant by the unit cost of producing this energy by an equivalent supply. From this yearly total would be subtracted the annual cost of operating and maintaining the hydro plant. The remainder would then be capitalized and the result added to the capacity cost already mentioned, to give the total cost that would be justified for the hydro plant.

The importance of the present tendency toward simplification was set forth by Mr. White. He called particular attention to the omission of the power house superstructure, simplification of cranes, etc.

POWER STORAGE

"Economic Problems Relative to Power Storage on a Large Scale" was the subject of one session on Monday afternoon, June 23. The other dealt with "Earthing, Lightning Protection and the Effects of Power Lines on Telephone and Telegraph Lines."

In the power-storage session an elaborate analysis of pumped storage as a method of supplying the peak load of a metropolitan area was presented by Ing. E. Bodenseher and Ing. R. Gabler, of Austria. For a special case they worked out the outline design of an 80,000-kw. pump accumulator plant, with an 800-ft. head, annual output being 80,000,000 kw.-hr. Average efficiency of this storage was computed to be 61.3 per cent (75.3 per cent for pumping and 81.3 per cent for the turbines). It was found that the best yearly efficiency was obtained with graduated loading of the pump and loading of the turbines for instantaneous peaks.

From this study the authors reached the conclusion that pumped storage is economically superior to stand-by steam plants if local conditions are favorable to the erection of the pump accumulator system at low cost.

Promising new applications of the Ruths accumulator were described in a paper by N. Frenne and Th. Stein, of Sweden, who pointed out that steam accumulators may be erected in old power stations in the neighborhood of the peak-load consumers within towns, thereby considerably reducing transmission costs.

They described the large Ruths plant put into operation in November, 1929, at the Charlottenburg power plant of the Berlin municipal electricity works. It consists of 16 Ruths accumulators and two Ruths turbines, and covers a load of from 40,000 to 50,000 kw.

BOILERS AND FURNACES

The session on "Boilers and Furnaces," on Tuesday morning, June 24, included many papers of interest to the readers of *Power*. Another session the same morning, "The Water-Power Industry in Individual Countries," also held much of value. A third session covered "Cost and Comparative Efficiency of different Types of Energy From the Consumer's Point of View."

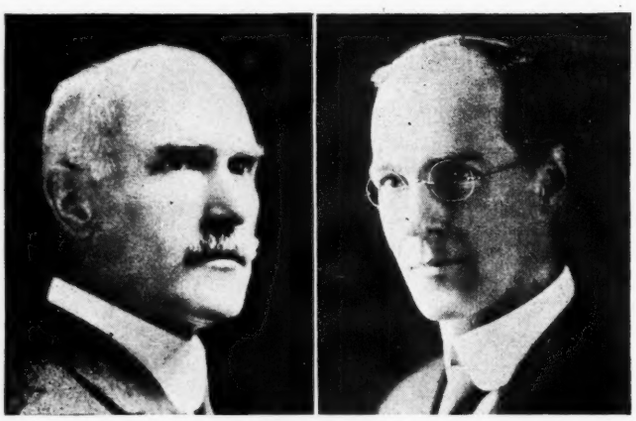
In a very brief paper on "Intercrystalline Cracking in Steam Boilers," F. G. Straub (U. S. A.) emphasized some significant facts, the chief being that no boiler with inside calking *only* had yet cracked in America, although millions of dollars' worth of boilers have been put out of service by intercrystalline cracks.

COAL FIRING

American progress in coal-firing of boiler furnaces was covered in a joint paper by H. W. Brooks, E. G. Bailey, W. L. Martwick, F. H. Daniels, H. D. Savage, and T. H. Banfield. In the introduction, Mr. Brooks showed that, contrary to common opinion, new methods of firing by no means dominate the field. "A fair estimate," he said, "of the annual tonnage of total coal burned under American boilers will approximate as follows: hand-firing, 275,000,000 tons; underfeed stokers, 100,000,000 tons; chain-grate stokers, 40,000,000 tons; pulverized coal, 25,000,000 tons; total, 440,000,000 tons."

"Even during the past seven years, since pulverized coal has been universally recognized not only as to technical feasibility but also as to operating practicability, United States Government statistics have shown that stokers continue to hold their own in serving about 60 per cent of all water-tube boilers manufactured.

"Both pulverized coal and stoker equipment manufacturers have concentrated on that vast field of inefficiency represented by the hand-fired plant. What pulverized fuel has gained at the expense of stokers in the larger and most modern plants, stokers have more than regained in the conversion of hand-fired plants. At the present rate of conversion, with the possible exception of railway locomotive hand-firing, few, if any, such installations will remain within the coming decade. The city of Chicago has, in fact, recently abolished by law new installations of hand-firing in the case of all boilers exceeding an output of 300,000 B.t.u. per hour.



E. R. Fish listed the "points" of high-capacity boilers

A. G. Christie surveyed turbine trends and practice

Mr. Brooks, as well as several of the other participants in the paper, pointed to the growing popularity of the unit pulverizer.

"By a large variety of applications now in service under practically all types of load conditions," said Mr. Bailey, "pulverized-coal firing has today established itself as being without doubt the most reliable combustion method for high-capacity units. Capacity limitations placed upon furnaces, because of their inability to withstand high rates of combustion, have been largely removed by water-cooled walls.

"An important factor tending toward the present general adoption of the direct-fired system has been the

development of basically sound principles of coal pulverization."

Discussing underfeed stokers, Mr. Daniels said that a length over 20 ft. is not uncommon and that coal burning rates of 70 to 75 lb. of coal per square foot are not unusual. "Water-cooled furnace walls," he said, "have made this higher heat release possible, by preventing much of the clinker and slag difficulties and by giving a furnace lining which will stand up under this high heat release."

"Today," he stated, "stokers are underfeeding coal 18 to 20 ft., compared with 6 to 7 ft. ten years ago."

Chain-grate stokers for American free-burning coal of the Middle West, lignites, and sub-bituminous coal of Colorado, Texas, and Dakota, anthracite and coke breeze, are now built in sizes of 24 ft. x 22 ft. (528 sq.ft.) according to H. D. Savage.

From Ewing Galloway

As a beauty spot and tourist's mecca, the San Souci Palace at Potsdam, just outside of Berlin, rivals India's Taj Mahal

COMBUSTION CONTROL

The principles underlying automatic control of boiler plants were outlined in a paper by E. G. Bailey. "Automatic combustion control," said Mr. Bailey, "is usually installed in a boiler plant to effect a saving in fuel due to more efficient operation. This saving alone has in numerous cases more than paid for the initial cost of the control during the first few months of service. In addition to the fuel saving, however, there is usually a considerable saving in cost of labor, as the number of boiler-room employees may be reduced. Many of the new stations are designed with boilers to operate at 1,300 or 1,400 lb. and to be equipped with pulverized-coal-burning equipment, water-cooled furnace walls and other expensive apparatus which will permit of operating at maximum efficiency. To capitalize on this investment, it is essential that the equipment be operated under conditions for which it is designed.

HIGH CAPACITY BOILERS

Following are excerpts from the paper of E. R. Fish (A.S.M.E.) on economic developments and design of high capacity steam boilers:

"The use of the unit mill system is growing in favor for plants of all sizes.

"In some cases the exit gases from the boiler proper are designed to run as high as 1,200 deg. F. If temperatures exceed 600 deg. F. for any considerable time the use of an economizer is indicated.

"If the arrangements in any plant are such as to make it possible to use greatly heated air, an air heater is a highly desirable piece of apparatus to effect a further thermal saving.

"Partial or full automatic control should be installed in order that all the various factors may be properly co-ordinated. It is only by keeping the CO_2 at a maximum and escaping gases at a minimum temperature that economical operation can be obtained."

RUSSIAN FUEL EXPERIMENTS

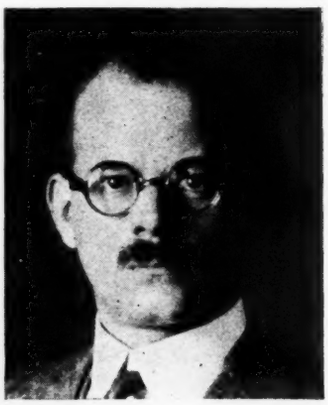
Extensive experiments have been carried out by the State Thermo-Technical Institute of Moscow on the combustion of fine fuel in a state of suspension. Fuels investigated include milling cutter peat, sawdust, rice husks and brown coal. The results of these experiments were reviewed by Prof. L. K. Ramzin. He reported that sawdust containing many fine particles, and, having a moisture content not exceeding 40 per cent, may be burned in suspension without the addition of other fuels.

Another paper presented by Professor Ramzin contained an exhaustive analysis, both theoretical and practical, of the preparation and combustion of pulverized fuel. This is based largely on experiments made at the Thermo-Technical Institute. Some of the interesting conclusions drawn by Professor Ramzin may be sum-

marized as follows: "The belief commonly held concerning the expensiveness of pulverized fuel, as compared with the mechanical stoker, is entirely erroneous, if the unit system is employed."

"The greatest and most incontestible advantages are offered for anthracite culm and lean coals fired in the pulverized form. This explains why all the new electrical stations for pulverized fuel burning at present under construction in the U.S.S.R. are primarily designed for the two above classes of fuel."

Professor Ramzin pointed out that to burn such fuel successfully it is necessary to pulverize it finely, to maintain only a moderate combustion rate, and to use a special type of mill. He said that Russian experiments and experience indicated the superiority of the unit system for all fuels and all types of plants. He stated definitely that the widespread belief that moist coal must be dried before pulverizing is a fallacy and that, as a matter of fact, grinding can be carried on in high-speed impact mills in spite of a considerable moisture content of the coal to be ground.



H. W. Brooks surveyed trends in fuel burning

▼

RADIATION IN FURNACES

A third paper by Professor Ramzin constituted a profound contribution to the subject of radiation as applied to boiler furnaces. A geometrical application of the laws of radiation led him to the conclusion that, with small error, the effective radiant-heat-absorbing surface of the lower nest of boiler tubes is equal to the breadth of the nest multiplied by the tube length.

Julius Kuttner got down to brass tacks on Diesel power (last week's report)

Experimental work along these lines at the Thermo-Technical Institute led Professor Ramzin to practical conclusions of considerable interest. He developed there a novel design of radiant boiler after preliminary experiments had shown that it is economical to reduce the gas temperature to between 1,400 and 1,800 deg. F. by radiation before permitting heat transfer by convection. The ordinary water-wall furnace, he pointed out, does not remove this much heat by radiation. His boiler is provided with a radiation section consisting of horizontal tubes arranged in vertical rows of about five tubes. The horizontal space between the tubes is from 20 to 24 in., allowing radiation each way from the hot gages.

It was claimed by Professor Ramzin that the results obtained with this boiler will revolutionize boiler design, greatly reducing the cost of the boiler as such, and transferring most of the convection work to superheaters, economizers, and air heaters. He pointed out that this result would be particularly desirable with high pressures.

CANADIAN POWER RESOURCES

An exhaustive report on water-power resources of Canada and their development was presented by J. T. Johnston. This discussed the situation for the Dominion as a whole, and then gave detailed figures for each of the provinces. The most recent estimates of the water power available in Canada, according to Mr. Johnson, allow about 20 million 24-hr. horsepower under conditions of ordinary flow, or 33 million 24-hr. horsepower ordinarily available for six months of the year. These resources are well distributed among the provinces.

On a commercial basis, according to Mr. Johnston, the available water-power resources would probably warrant a total installation of about 48 million horsepower, so that the existing installation may be said to be slightly more than 13 per cent of the recorded resources of the Dominion.

"In addition to the large increase in water-power installations during the past six years," the report stated, "there are a number of undertakings under construction at the present time the total of whose initial installations will amount to 550,000 hp. When completed to their ultimate designed capacity these will add to the Dominion's total more than two and one-half million horsepower. There are, as well, numerous projects in the prospective stage, many of which will undoubtedly materialize in the near future, and will add greatly to the program of development.

"In the Canadian central station industry over 95 per cent of the installed primary power is hydro. This generates almost 99 per cent of the total kilowatt-hour output. Pulp and paper is Canada's greatest manufacturing industry. As the production of newsprint requires an installation of approximately 100 hp. per ton of daily output, it is obvious that Canada's supremacy in its manufacture is due no less to her abundant supplies of low-price power than to her extensive forest resources. More than 90 per cent of the motive power in this outstanding industry is derived from water. The pulp and paper industry maintains a hydraulic installation of 577,000 hp., and, in addition, purchases approximately 860,000 hp. of electrical energy for power purposes from central electric stations. Considerable off-peak and surplus power is also purchased from central electric stations for use in electric boilers."

TIDAL POWER

An ambitious plan for the development of tidal power was outlined by M. E. Piaggio, of Argentina, who said that the Argentine is favorably situated for such a development. In the region of Patagonia, for example, it provides gulfs and inlets with tides rising up to 39 ft.

A national committee was appointed in 1923 to study the matter. In 1928 this committee published its report, which includes a number of preliminary plans devoted to tide-energy installations in the Gulf of San José and in the Deseado River. The San José scheme provides for the inclosure of an inlet by means of a dock power

house and a four-mile breakwater, thus inclosing an area of 300 square miles.

The tide amplitude varies between 15 and 24 ft., and the head created by regulating the flood gate is from 1½ to 6 ft., working the turbine for five hours of the six-hour tide. It is proposed, according to Mr. Piaggio, to use turbines of the propeller type, with ejectors. The power, he said, will vary from 240,000 kw. to 1,000,000 kw. with a daily energy output of 10,000,000 kw.-hr. It is proposed to transmit this energy to Buenos Aires —a distance of 680 miles. The installation, which is estimated to cost altogether $220,000,000, will probably not be made in the near future, according to Mr. Piaggio.

BYPRODUCT POWER

"Combined Heat and Power Supply Plants" and "Switchgear, Including Automatic Control Apparatus for Power Stations and Remote Metering and Signaling Apparatus" were the subjects of the two concluding technical sessions held on the morning of Wednesday, June 25. In the former session several papers of interest to *Power* readers were presented.

Comparing the savings from high pressures in condensing plants and back-pressure plants, Ing. A. Demmer, of Austria, reached the conclusion that increasing the pressure is more profitable with condensing turbines than when back-pressure units are employed. This conclusion, which is diametrically opposed to that ordinarily held, was based on the fact that the condensing plant makes better use of bleeder heating and that therefore, with a given flow of steam in both places, the ratio of additional coal burned (by higher pressure) to additional kilowatts produced will be somewhat lower with a condensing plant.

W. F. Ryan (A.S.M.E.), in his paper "Combined Heat and Power Supply in Industrial Plants," pointed to the recent increase of pressure in industrial plants. He stated that the majority of high-pressure condensing plants have proved thoroughly reliable in operation. He said, also, that the reciprocating engine has some advantages over the steam turbine as a byproduct power producer in sizes up to 5,000 kilowatts.

"Cost of electric power in a high back pressure industrial plant," said Mr. Ryan, "is largely a matter of bookkeeping, because of the lack of uniformity in dividing fixed charges and operating expenses between the two items in electric power and process steam. In the larger plant the cost should not exceed five mills per kilowatt-hour.

[An abstract of Mr. Ryan's paper appears on pages 30 and 31.]

POWER IN STEEL PLANTS

C. W. E. Clarke (U. S. A.) in a paper on power production in the steel industry, said that certain refinements justified for fuel economy in central stations might not pay their way in the large steel plants, because of the amount of waste fuel available. This, he felt, applies to the use of higher steam pressures.

However, Mr. Clarke pointed out, where excess power available from waste heat can be sold locally, either to neighboring manufacturers or to public utilities companies, the situation is changed, and in such cases expenditures made for the sake of higher efficiency must be evaluated on the basis of increased receipts from the sale of power.

There has been, Mr. Clarke said, a notable increase in the size of units installed. Today it is not uncommon to find in steel mills boilers of 25,000 sq.ft. of heating surface, blowers displacing 60,000 cu.ft. of air per minute (one is now under construction for 110,000 cu.ft.) and turbine generators of 20,000 to 30,000 kw. capacity.

[An abstract of Mr. Clarke's paper will appear later in *Power*.]

EXCHANGE OF POWER

Exchange of power between industrial plants and central stations was presented as a logical development of the interconnection of central stations by B. F. Wood (A.S.M.E.). After explaining in detail the many advantages that have arisen from the interconnection of central stations, he described the Deepwater station which supplies steam and power to the duPont Company and power to two utility systems. His paper, which outlined in some detail the fundamental principles on which sound contracts between utility and industrial must be based, will be abstracted later in *Power*.

De Cou from Ewing Galloway

A quaint street in Rothenburg—such scenes greeted delegates in their tours after the conference

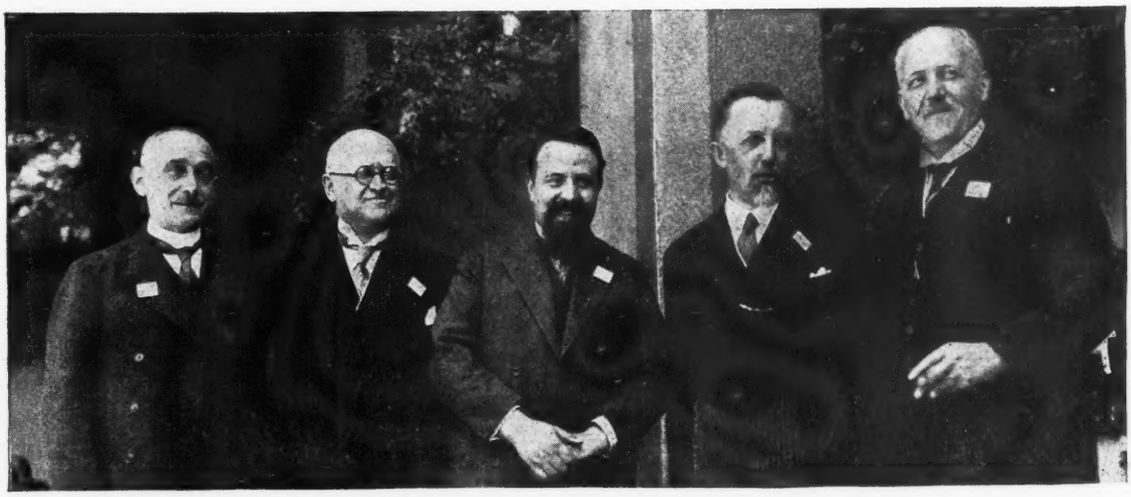
CAMERA NEWS of the World Power Conference

All Photos by P.&A.

Sir Charles Parsons of England delivers his address at the opening session of the conference. Others at the speakers' table are President von Miller, General Director Koettgen and German Chancellor Bruening

Space is crowding out matter, Professor Albert Einstein tells members of the conference

Refreshments aid the delegates in considering weighty conference matters at one of the special sessions



Getting a bit of fresh air in the garden of the Kroll Opera House, left to right: Professor Aufhauser, Professor Lohse, M. von Straworen of Holland, Dr. Matschoss of Germany and Dr. Petersen

Delegates of more than 30 nations assembled in the Kroll Opera House for the opening ceremony of the conference

Caught outside the Kroll Opera House, Oscar von Miller does not want to be photographed

Keeping Steel Gaskets Tight AT 1,350 LB.

By W. P. SAUNIER
Engineering Department,
W. S. Barstow & Company, Inc.

Copper-plated gaskets of dead-soft steel are making an excellent showing under this pressure at the Holland station

MUCH interest has been shown by engineers in the gaskets used at Holland station, doubtless aroused by the fact that Holland is the first 1,350-lb. pressure plant in this country using gaskets on the main steam lines. All other plants, it is believed, having used Sargol or Sarlum joints. This article will be limited to a description of the gaskets on high-pressure piping.

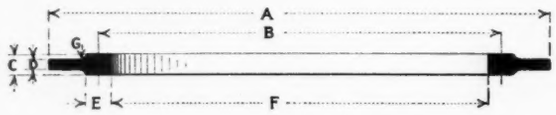
On the 4-in. and 6-in. boiler-feed lines and on the 8-in. boiler leads and 10-in. main steam line the gaskets are of copper-plated soft steel, held between the serrated faces of van stoned pipe. The details of the gaskets are shown in Fig. 1, from which it will be noted that the outside diameters of the sizes two inches and larger are the same as the standard raised-face diameters for van stoned pipe and flanged fittings. The contact faces are rather narrow, and the center of pressure in each case is about $\frac{3}{8}$ in. beyond the outside diameter of the pipe. Fig. 3 shows a typical gasket in place.

For joints smaller than two inches in size, the gaskets have outside diameters such that they will just fit inside the bolts. Fig. 4 shows how these gaskets look in place between a pair of flanges. Gaskets of $\frac{1}{32}$-in. asbestos composition sheet were originally installed on these joints, but, due to the narrow contact faces, a number of the gaskets failed after a short period of use and all the small soft gaskets were replaced by steel.

Fig. 5 shows a section through a step joint frequently used on boilers, steam reheaters, and superheaters, and Fig. 6 a section through a typical joint used for water column connection and boiler drain piping. These have serrated contact faces and were made up with asbestos sheet packing, but it was felt desirable to refit all such joints with copper-plated soft steel gaskets, the details of which are shown in Fig. 2.

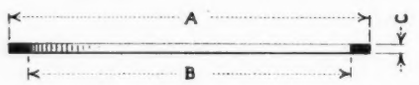
The bonnet joints on the main steam and boiler feed gate and non-return valves are of the tongue and groove type and were made up with asbestos sheet packing. After several weeks' service, one of these gaskets blew out and was replaced with a corrugated Monel gasket approximately 0.018 in. thick. The bonnet joint faces are not serrated, and the bonnet flanges and bolts are relatively weaker than the line flanges, so that it seemed inadvisable to use a narrow-faced soft-steel gasket, which, it was felt, requires a high loading.

The asbestos sheet bonnet gaskets on all the valves mentioned have been replaced with Monel, the idea being that in case a gasket does leak it will not blow out and require shutting down the plant immediately, as seems to be the case with the asbestos sheet gaskets. This reasoning was applied in the case of the stepped joints, although no blowouts occurred at Holland with joints of this type. The globe and check valves were originally



Nominal Pipe Size	A	B	C	D	E	F	G
1"	3⅛"		0.125"	0.0625"	0.187"	1.625"	1/32"
1¼"	3½"		0.125"	0.0625"	0.187"	1.9375"	1/32"
1½"	3⅞"		0.125"	0.0625"	0.187"	2.25"	1/32"
2"	3⅞"	3.06"	0.25"	0.125"	0.187"	2.87"	1/16"
2½"	4⅛"	3.56"	0.25"	0.125"	0.187"	3.37"	1/16"
3"	5"	4.26"	0.25"	0.125"	0.187"	4.07"	1/16"
3½"	5½"	4.76"	0.25"	0.125"	0.187"	4.57"	1/16"
4"	6 3/16"	5.24"	0.25"	0.125"	0.25"	4.99"	1/16"
5"	7 5/16"	6.32"	0.25"	0.125"	0.25"	6.07"	1/16"
6"	8½"	7.38"	0.25"	0.125"	0.25"	7.13"	1/16"
8"	10 5/8"	9.38"	0.25"	0.125"	0.312"	9.07"	1/16"
10"	12¾"	11.5"	0.25"	0.125"	0.375"	11.12"	1/16"
12"	15"	13.5"	0.25"	0.125"	0.375"	13.12"	1/16"

Fig. 1—Copper plated steel gasket used on 4-in. and 6-in. boiler feed lines, on 8-in. boiler leads and on 10-in. main steam line



Nominal Pipe Size	A	B	C
1"	1.50"	1.125"	1/16"
1¼"	2.855"	2.48"	1/16"
2"	3.605"	3.23"	1/16"
3½"	5.48"	5.105"	1/16"
4"	6.16"	5.66"	1/16"
8"	10.605"	9.98"	1/16"
16"	16.23"	15.48	1/16"

Fig. 2—Copper-plated steel gaskets adopted for joints shown in Figs. 5 and 6

made up with Monel bonnet gaskets, and they have given no trouble.

The 1-in. drain and instrument connection valves on the main steam and boiler feed lines have bonnet gaskets of $\frac{1}{64}$-in. copper. Although it is known that copper has given trouble in pipe-line gaskets at temperatures of 700 deg. F. and over, it may be that a very thin copper gasket will prove satisfactory for valve bonnet service. At any rate, no trouble has occurred with these gaskets during the ten weeks of use.

Specifications for the steel gaskets called for dead soft steel with copper plating approximately five-thousandths of an inch in thickness. The material used was S.A.E. specification 1010 having 0.05 to 0.15 carbon, 0.3 to 0.6 manganese, 0.045 maximum phosphorus and 0.05 maximum sulphur. This steel, rolled in strips $\frac{5}{16}$ in. thick, was annealed at a temperature of 1,450 deg. to 1,600 deg. F. for at least 50 hours and slow-cooled to 1,000 deg. or less. The gaskets were machined from the plate as it came from the annealing furnace and then copper plated.

Tests on a machined gasket prior to copper plating showed an average Brinell hardness of 71, which is exceedingly low. Since the faces of pipe and castings between which the gaskets are placed have a hardness of from 100 to 170 Brinell, it is evident that the serrations on the flanges will be impressed upon the base metal of the gasket, the copper plating being required only to prevent corrosion. Gaskets that have been removed show clearly the impressed serrations.

The specifications for serrations on van stone flange, fitting, and valve faces called for "40 to 60 V-grooves per inch," but it was not always possible to get as many serrations per inch as specified; so some of the facings have approximately 32 grooves per inch. Most of the facings, however, have over 40 serrations, the maximum number used being 48 per inch. In all cases the serrations were made with a diamond point tool feeding across the face, giving, therefore, what is commonly called a spiral groove. So far, it appears that the smaller number of grooves is quite satisfactory and may even be preferable to the number specified, and it also seems that the spiral grooves are satisfactory even with very narrow contact faces. It was felt desirable to have clean-cut serrations.

The service given by the steel gaskets has been satisfactory so far, only two gaskets of this type having required removal. The first failure was an 8-in., which leaked badly on the first hydrostatic test. Examination disclosed a deep scratch across the contact face, indicating that the gasket was defective. The second failure occurred at a 4-in. joint adjacent to a regulating glove valve in one of the boiler feed lines. The valve had been used for about a month to regulate the water feed to one of the boilers. Excessive vibration was caused by a 400-lb. pressure drop across the valve. The contact faces of the gasket gave no evidence of scoring, but a new gasket was put in. The regulation of the feed was changed to a hydraulically operated valve with which the vibration is greatly diminished. The joint has not leaked since.

After one of the boilers had been on and off the line a number of times it was submitted to a cold water test pressure of 2,100 lb. Under this test four external water-wall joints, out of a total of over 150 steel gasketed joints under test, leaked enough to demand tightening of the bolts. When the boiler was put in service the leaks stopped. Since then no trouble has been had with the joints. Although the steel gaskets have not been in service long enough to establish definitely their fitness for the work, the evidence is conducive to optimism.

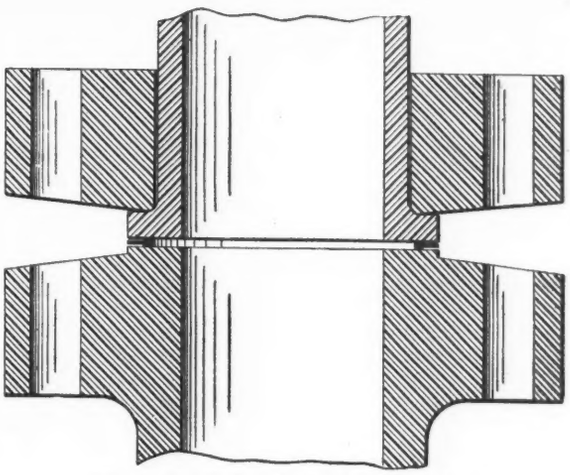


Fig. 3—Typical gasket (Fig. 1) in place between flanges on an 8-in. line

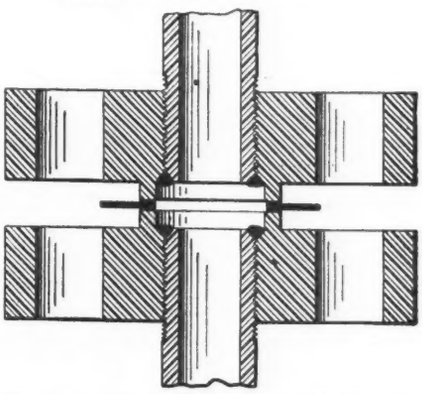


Fig. 4—Copper-plated steel gasket on 1-in. line just fits within bolts

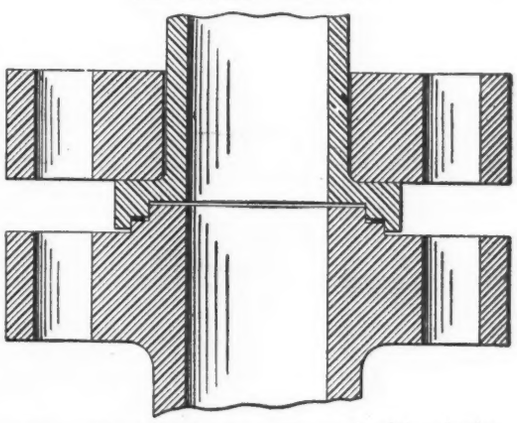


Fig. 5—Stepped joint formerly used with asbestos sheet packing (here shown for 3½-in. line)

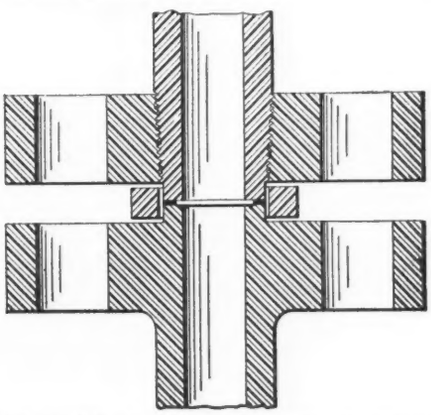


Fig. 6—Pipe to fitting joint in which asbestos packing was formerly used (1-in. line)

Auxiliary Starter Prevents Burning of Controller Contacts

By Albert A. A. Rodriques
New York City

ELECTRIC MOTOR STARTERS are not always sufficiently flexible in their application to meet some of the conditions of machine and motor operation. If operations other than those for which a starter was primarily designed are attempted, it is generally detrimental to the starter.

Three common hand-operated motor starters are the armature-resistance type, for starting duty only; armature resistance, for regulating duty; and a double-arm type, for starting duty through armature resistance and speed adjustment by varying a resistance connected in series with the motor's field circuit. Each type is designed for a special duty, and the only quality common to all of them is that they can be used to put a motor across the line safely.

In the operation of a motor on a load that required a heavy starting torque, started by a manual-type controller with field adjustment, it was frequently necessary to jog the load. This required that the motor turn a few revolutions under more than full load and then be disconnected from the line. To obtain the few turns of the motor, the arm was brought to the second or third contact point of the starter, held there for a few seconds, then allowed to drop back to the off position. Destructive arcing action thus produced, intensified by high-load current, burned out the contact points and shoe very quickly.

Repairs to the damaged starter were made by filing the contacts to a smooth surface and bringing them up to the correct level by placing washers under their heads. When the stems on the contacts were not long enough to do this they were replaced by new ones. This trouble became so serious that it was decided to make an auxiliary starter designed to stand the severe conditions when jogging the motor.

This starter, Fig. 1, was made with a slate base which measures 5x8 in., on which was mounted a stationary and a movable carbon contact. The two carbon contact holders are such as used on the direction switches of an elevator control board. A piece of $\frac{3}{8}$-in. conduit and a $\frac{3}{8}$-in. cast tee, the latter drilled through to remove the threads, made up the contact arm. Pieces of angle iron formed the pivot bracket and an iron loop limited the arm's movement. A hard-wood knob provided a means of manipulating the arm without danger of shock. A flexible copper shunt connected to the tee, and a binding post completed the connection between the arm and the motor circuit.

The carbon holders used in the making of this auxiliary starter were no longer suited for their original purpose, being grooved by wear and the effect of current leakage. When their stems were cut to the proper length the remaining portions were not round and had to be turned in a lathe before they could be threaded.

The diagram shows how the auxiliary starter was connected in the motor circuit. To simplify the connections, only the armature circuit is shown complete through the starter. To connect the auxiliary starter into the motor circuit a fifth connection X was put on the starting box and joined to the first point on the starting resistance. When it is necessary to jog the motor the auxiliary starter is closed by hand. This completes a circuit from the + side of the line to the L_1 terminal on the starting box, through the arm and carbon contacts of the auxiliary starter to the X terminal on the starting box. From here the armature circuit is completed through the starting resistance, the motor's armature and to the — side of the line. Thus the motor can be started on slow speed and stopped at will without moving the arm on the starting box. This relieves the contacts on the starting box from breaking the heavy current that they are not designed for, and cures the trouble of burned contacts. The auxiliary starter is mounted in a mica-lined iron box on top of the hand-starter cabinet. The carbons used have a face dimension of $1\frac{1}{2}$x2 in., and are the same kind used on many elevator contactors.

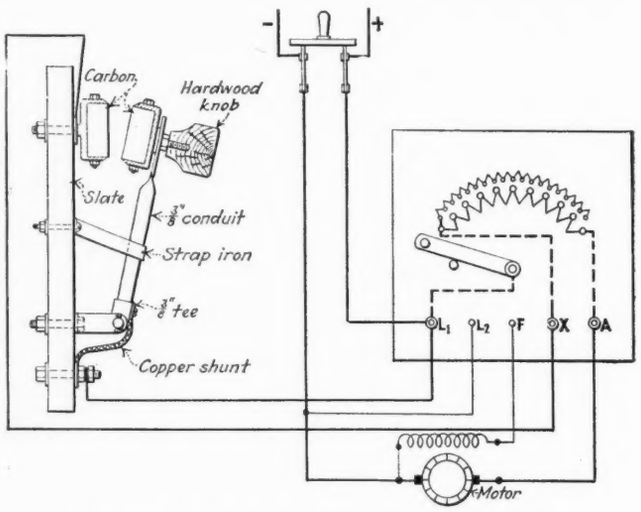


Fig. 3—Diagram of auxiliary starter connected to the motor and starting box

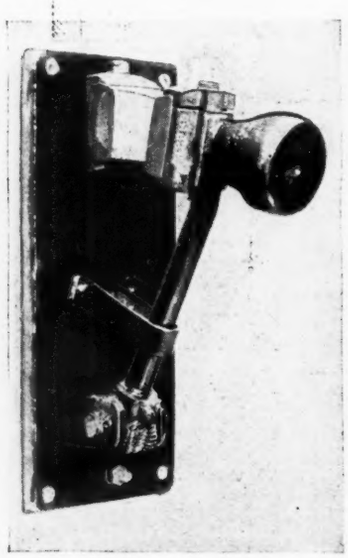


Fig. 1—Auxiliary starter used to jog the motor

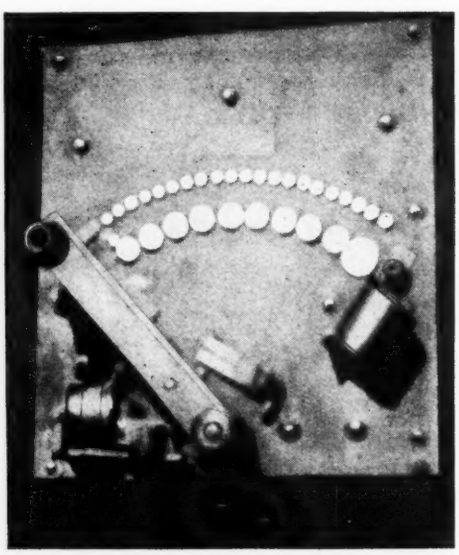


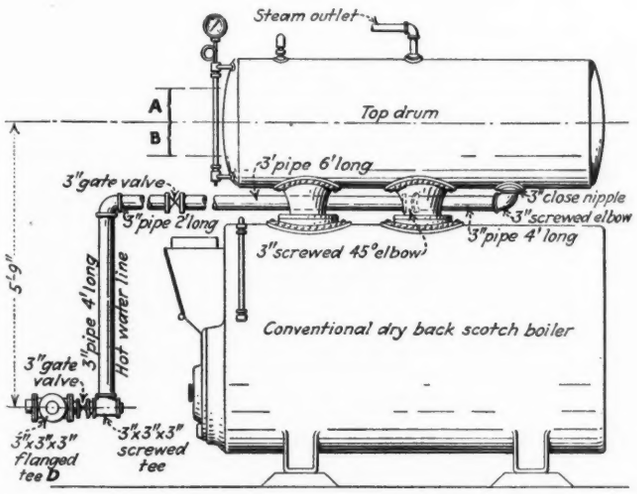
Fig. 2—Type of starter on which the contacts were burned

. . . RIGHT OUT OF THE PLANT . . .

Why the Difference in Flow With Slight Change of Head

A RATHER INTERESTING phenomenon has recently come up in the industrial plant with which I am connected. A small special boiler, as shown in the illustration, is equipped with a top water drum 30 in. in diameter x 7 ft. long. The function of this boiler is to furnish steam and hot water for testing equipment being manufactured in the plant. The boiler is designed for a maximum working pressure of 300 lb., and the test pressures employed range from 0 to 300 lb. The hot-water connection is taken from the bottom of the top drum, as shown in the sketch. The top drum is calibrated so that it is possible to tell just how much water is taken from the boiler during any particular test.

Shortly after installing this test boiler it was noticed that the capacity of the equipment being tested was always greater when the water level in the top drum was high, as indicated on the sketch by *A*, than when low, as shown by *B*. A short run of pipe was connected to the flanged tee *D* so that water could be drawn from the



Arrangement of test boiler with connections

boiler and discharged to atmosphere without any restrictions in the pipe line other than those shown. It was found that at a boiler pressure of 140 lb. approximately 16 per cent more water was discharged through the pipe while the level in the boiler was falling through *A* than when falling through *B*. This ratio of quantity of discharge appears to be about the same for boiler pressures both above and below 140 lb. During the tests the boiler pressure remained constant. Any opinion as to why the marked differences in flow occur for small differences in water level will be welcomed.

Three Rivers, Mich. P. L. ULRICH.

The Ultimate Temperature and Pressure

DESK calculations have often proved a danger to sound judgment of engineering problems. As a rule, "thermodynamics" is the fog screen behind which there is a surprising output of speculations which, while generally starting off from quite correct assumptions, lead (by neglecting quite fundamental engineering facts), to erroneous and misleading conclusions.

K. A. Mayr in his article "What Is the Ultimate Temperature, Pressure, Reheat?" (*Power*, April 1) has gone to a lot of trouble in collecting calculations for all sorts of "cycles" into two tables. For purposes of comparison it is, of course, to some extent irrelevant what efficiencies are taken for high- or low-pressure turbines, boilers, reheaters, etc., as long as there are no good reasons why different figures for certain efficiencies should and must be taken for different "cycles." I refer especially to the boiler efficiencies, assumed by Mr. Mayr to be always 90 per cent (a remarkably good figure in itself, even for a comparative table, to which every operating engineer will look up with envy!).

Mr. Mayr tells us also in much detail about the "beneficial" effects of higher feed water temperatures which are supposed to be merrily rising with the temperature. A limit to the bonanza is expected only if the bleeding taps enter the high-pressure turbine cylinder itself!

Now there is no more fatal mistake than this. Evidently Mr. Mayr has altogether overlooked certain fundamental facts in boiler design, namely, that the higher the temperature of water entering the boiler, the poorer the utilization of combustion gases, which will have to escape at higher temperatures, and heat, just as merrily, the universe.

Only recently I had the case of a steam plant where boiler makers of world standing declared that for the same steam pressure (in the neighborhood of 1,000 lb.) they expect a boiler efficiency about 5 per cent higher if the feed water temperature is reduced from 450 deg. F. to about 310 deg. From this it may be safe to assume that, by lowering the feed temperature from 450 to 380 deg., the boiler efficiency would be increased by, say, 2 per cent. This entirely upsets the calculation results arrived at by Mr. Mayr. Perhaps he will be kind enough to correct them, which will show that there is little or no use to speculate about pressures much above

1,400 lb., while the "cycle" chosen will depend on the temperatures which can be reliably managed with commercially available materials. The final economic feed-water temperature will surely not be much higher than about 320 deg. unless, besides heating of the combustion air, some other use is made of the hot flue gases.

Tokyo, Japan. F. NETTEL.

A Reply to Mr. Nettel

[The foregoing letter of Mr. Nettel was shown to Mr. Mayr, who submits the following reply.—Editor.]

I HAVE read with great pleasure the remarks which Mr. F. Nettel made on my paper, because they were written in such "cheerful" language. I have always believed that it is the foremost task of the engineering profession to study the laws of nature and to apply them to the benefit of mankind. For an engineer it seems to me to be essential to know exactly, and not through a fog screen, what nature has to offer us and to make the most efficient use of it.

I wonder how a power-plant designer can properly use the great amount of apparatus which is today at his command—boilers, turbines, heaters, reheaters, and what not—unless he co-ordinates them in the right way, with the aid of thermodynamics and the steam tables, and unless he operates each piece of equipment at conditions most suitable to efficiently serve the final purpose of the whole plant. Such investigations, however extensive they may be, mean no trouble at all for a real engineer, but just as much fun as it is for a financier to calculate the returns of an investment if he uses several types of business organizations, or for an explorer to investigate new countries. Should such a research reveal that one or the other apparatus is not yet developed for conditions which are most desirable according to the laws of thermodynamics, it again would be the task of the engineer to see that he make the thing so that it does the job in a way that it not only works nicely in itself and pleases the operating engineer by its smooth running, but that it also answers its higher vocation, i.e., to make the utmost use of what nature has in store for us.

Mr. Nettel objects to the assumption of the same boiler efficiency for all cycles, or, better, for all feed-water temperatures. A boiler designer who also knows something about heat transfer will always be in a position to make his heating surfaces sufficiently large to keep gas losses at a point which secures the desired boiler efficiency. The higher the feed-water temperature the more he may gain by the use of air preheaters. If the heating surfaces are designed for a certain feed-water temperature the efficiency of this equipment will be higher for a lower feed temperature (because the heating, or, rather, gas-cooling, surfaces are then too large), and it will be lower if a higher feed temperature is used in this same steam generator (because the surfaces will be too small).

As there is a sufficient number of boiler equipment manufacturers and experts in calculating heat transmission in boilers, economizers, and superheater tubes, and also in air preheaters, who are in a position to design steam-raising equipment for a certain efficiency and for any predetermined feed-water temperature—which by no means need to be lower than the ones used in my paper—I do not see why I should change my cycles. I should rather advise Mr. Nettel that if he wants to operate his boilers with a feed water of 450 deg. and does not want to sacrifice any efficiency he should install a little more heat-transmitting surface, and an air preheater, if there is not one already. There are quite a number of high-pressure steam-generating units in this country fed with water around 400 deg. that operate at a much better efficiency than other units using colder feed water.

It must be admitted that the figure of 90 per cent as steam generator efficiency (including economizer and air preheater) may seem a little high to the average operating engineer, and certainly would involve a somewhat expensive installation, which is not always justified. In large and most up-to-date designed and operated power plants, however, this figure has often been obtained; there are plenty of test figures available in this country which go as high as 92 per cent. I wish to point out that I made separate allowances for the power consumption of the boiler auxiliaries; that the figure of 90 per cent comprises the whole steam-generating unit rather than the boiler only, which may have been the thought in Mr. Nettel's mind. I still feel that my figure of 90 per cent is justified, as I was very conservative in the turbine efficiencies, particularly those of the high-pressure machines.

If the boiler efficiency were lower throughout, it would only emphasize to a greater extent the increased over-all efficiency at initial steam pressures above 1,400 lb. per square inch. In fact, the over-all efficiency of a plant with 3,000 lb. initial steam pressure would be, in that case, a full point higher than at an initial steam pressure of 2,500 lb.

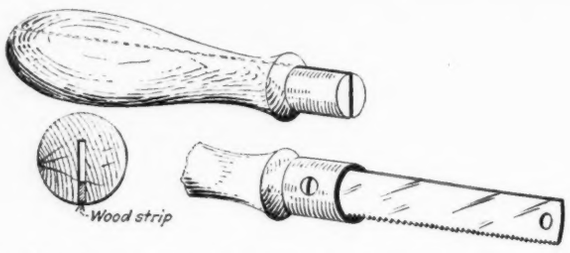
I do not venture to say what the final feed-water temperature, or any other condition, will or will not be; it was my endeavor to find out (without speculation, but using only values which are based on experience or which can safely be anticipated with a sufficient amount of engineering knowledge) what nature has in store for us in the properties of steam, and what we can expect without demanding too much of our steam power plant designers. Whether we can afford to shut our eyes to the economic possibilities offered by the conditions under investigation is a problem for the respective responsible authorities.

New York City. KARL A. MAYR.

Hacksaw for Confined Places

IN ALMOST every plant occasions arise when it is necessary to have a short or free-end hacksaw to do work in a confined space. Many plants are equipped with standard tools of this kind, but there are others where tools must be made up when occasion demands. A handy tool for this work and one that is readily made is shown in the accompanying illustration.

A handle of hard wood, preferably rock maple, with its ferrule tip $\frac{1}{2}$ in. in diameter and $\frac{3}{4}$ in. long, is sawed



Saw blade is slipped through handle and locked with screw

with a longitudinal cut-in from one side to $\frac{1}{4}$ in. past its center, as shown. The open edge of this cut may be closed by a thin strip of wood glued in, leaving an opening $\frac{1}{2}$ in. wide, the whole length of the handle, for the hacksaw blade to pass through.

A ferrule $\frac{3}{4}$ in. long, $\frac{1}{2}$ in. inside diameter, and $\frac{1}{16}$ in. or more in thickness, is driven on, and in one side of this a hole is drilled through metal and wood to the center, and tapped for a short No. 8 machine screw, to act as a set-screw against the side of the blade.

A whole or broken hacksaw blade may be run through the handle, and fastened by the set-screw, leaving any desired length projecting. Care should be exercised, however, in using this tool, as the blade must depend entirely on its own stiffness. CHARLES A. PEASE.

Monrovia, Calif.

Utilizing a Vacuum System for Heat Before Completion

AN UNUSUAL condition was recently encountered in furnishing temporary heat to a building at the Hudson River State Hospital, Poughkeepsie, N. Y.

A vacuum heating system being installed in the building was incomplete when heat was first required. Base-

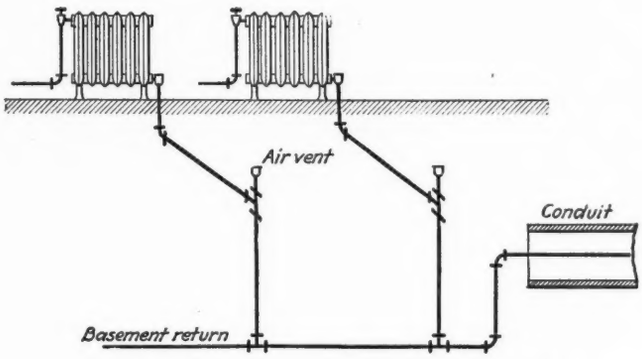


Diagram of radiator return lines with air relief trap on each drop leg

ment mains and returns and all radiator connections had been finished, so that low-pressure steam could be supplied to the radiators; but no vacuum pumps had yet been installed.

Heating-steam and return pipes ran from the hospital heating mains to the building through underground conduit. The conduit entered the building at a point higher than the basement returns.

No floor drains had been provided in the building basement to permit of wasting condensation from the radiators.

The fact that the main return in the conduit was higher than the building basement return at first prevented establishing flow of the radiator condensation from the basement returns to the main return in the conduit. This difficulty was overcome by installing radiator traps at the top of each return drop leg which lead into the basement return pipes, as shown in the sketch. These traps expelled any air that collected in the building returns and prevented them from becoming air-bound. The head of water in the pipes maintained a steady flow from the basement returns to the conduit return pipe.

Wassiac, N. Y. THERON W. BEON.

Pull Boxes Prevent Slipping of Lead-Covered Cables

A POWER COMPANY in the Southeast recently experienced trouble with a lead-covered cable installation consisting of five separate lines running parallel and rising up a steep slope. Each cable was inclosed in a metal conduit, the lines being spaced 6 in. apart. At the top of the slope, about 500 ft. above the power house, the cable was anchored to prevent its slipping.

After about a year's service, trouble developed; individual conductors were breaking under a heavy downhill strain. Investigation disclosed that expansion and contraction resulting from temperature variations was causing a heavy strain on the upper terminals.

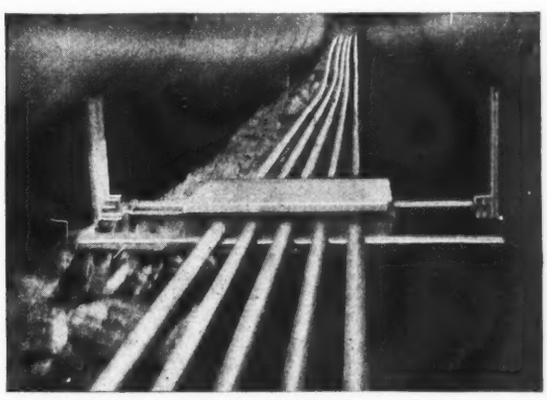
Four pull boxes of a simple design were placed at equal intervals along the line. Each pull box, acting as an anchor, counteracted any tendency on the part of the cables to move downhill. In this manner the total strain was divided between the four boxes.

The pull boxes consisted of a wood clamp secured to the cables and butting against the conduits, and a weather-proof metal box inclosing the clamp. To fasten the clamp, it was necessary to cut away each line of conduit for about 10 in. Considerable care had to be taken not to injure the cables during this process. It was finally decided to use diamond-point chisels, although this was probably the slowest method. The spacing between conduits prevented use of hacksaws, and burning would have caused injury to the cables.

After cutting the conduits, a wooden clamp was made by drilling a 3x5x36-in. maple block to fit the cables. This block, sawed through the center the long way, formed the two halves of the clamp, which were fitted around the cables and bolted together with $\frac{1}{2}$-in. bolts.

The conduit lines were firmly anchored to cross angles with U-bolts, thus making the lines rigid throughout their entire length. The clamps were secured to the cables butting against the conduits on the downhill side of the cut. The space in the cut above the clamp allowed the cables to move with expansion.

Around each clamp, and covering the entire cut, in the metal conduits, a weather-proof metal box was attached.



One of the four anchors placed on the line

The boxes were made in two sections, the lower section being slung on hangers below the conduits, and the second section, resting on the conduits, was bolted to the lower half. Packing boxes were provided where the conduit passed through, to prevent moisture from entering along the pipe. C. B. STOUGHTON.

Maryville, Tenn.

From Among Readers' Problems

Conducted by

L. H. MORRISON

RATING OF DIESEL ENGINES AT ALTITUDES—*Why is the horsepower of a Diesel reduced at high altitudes? How is the reduction calculated?* C. C.

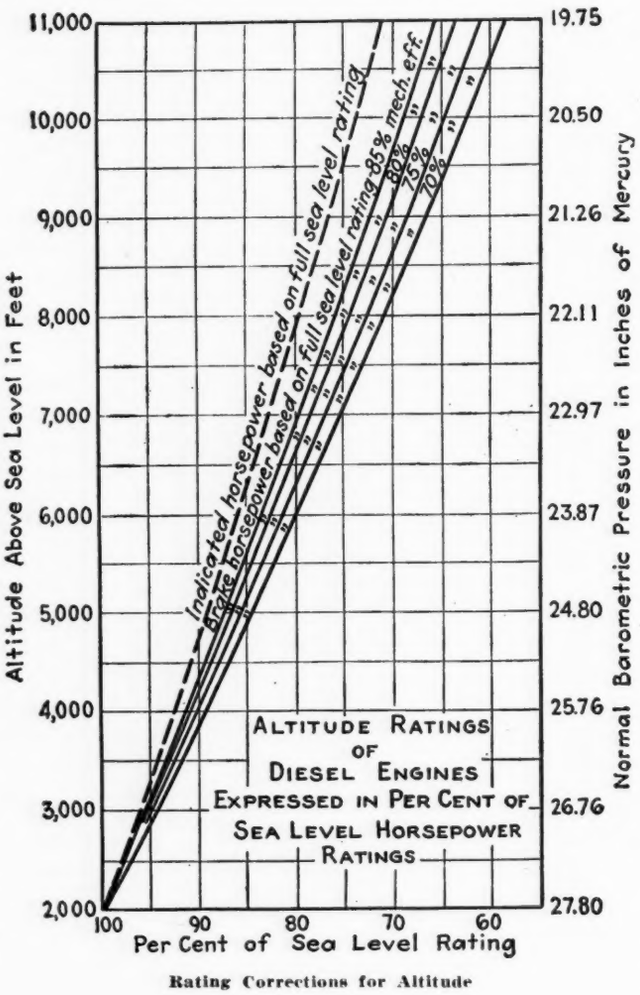
Due to the reduction in atmospheric density, the power which a given Diesel engine can develop decreases with an increase of altitude above sea level. The reduced atmospheric density limits engine horsepower in two ways: (1) it decreases the amount of oxygen available for combustion, and (2) it diminishes the power of the engine to get rid of heat by diminishing the weight of the heat-carrying medium passing out the exhaust. For all practical purposes, the maximum indicated horsepower may be considered to vary directly with the barometric pressure—the air temperature remaining the same. Brake horsepower, however, will not vary in exact direct proportion with barometric pressure, because of the variable effect of mechanical efficiency produced by the nearly constant friction horsepower.

Were Diesel engines rated exactly at a maximum horsepower at sea level, it would of course be necessary to revise ratings for very slight elevations above sea level. In that case it would likewise be necessary to revise ratings on days of low barometric pressure at sea level. Needless to say, these necessities would be quite inconvenient. In practice, however, Diesel engines are rated with power margins sufficient to remove the necessity of revision for slight changes.

The curves in the illustration present what the members of the Diesel Engine Manufacturers' Association agree shall hold for the correction of sea level ratings at various altitudes above sea level. It is to be noted that sea level ratings must be sufficiently conservative that no corrections need be applied below an altitude of 2,000 ft. The indicated horsepower from this altitude up is reduced in proportion to the reduction in barometric pressure. Brake horsepower curves for various sea level full load mechanical efficiencies are included.

In some cases manufacturers provide engines for altitude operation with means for supercharging the intake and with arrangements for holding a corresponding exhaust pressure. It is understood that engines so arranged shall be considered as operating at an altitude corresponding to the supercharging pressure as far as the application of the curve in the figure is concerned—due allowance to be subtracted for the power required for the supercharging.

In the past there have been instances of manufacturers guaranteeing full sea-level ratings for Diesel engines to operate at altitudes as high as 5,000 ft. The excuse for this practice has been that the engines in question had so great an overload capacity at sea level that the normal reduction in horsepower for 5,000 ft. altitude did not bring the true horsepower down to the nominal ratings. The result was that the sea-level buyer received an engine with a large margin of power; whereas the altitude buyer received very little, if any, power margin. The altitude buyer deserves approximately the same margin of power that the manufacturer considers advisable for sea-level units.



Rating Corrections for Altitude

HEATING A WATER TANK—*We have a 40x80 ft. swimming pool the total capacity of which is 130,000 gal. We drain out water once a week and fill with fresh. Water is pumped from wells, and its temperature is 52 deg., far too cold for comfortable swimming. We wish to heat this water artificially, raising the temperature to 78 deg. What would be the most efficient equipment to use and the manner in which to use it? We now have a vertical steam boiler, and at a steam pressure of 100 lb. it delivers a jet of live steam through a ¾-in. pipe in the deep end of pool four feet below the surface of the water. We are able, under favorable conditions, to raise the temperature of the water about 8 deg. with twelve hours of steady steam pressure, but, on the whole, results are unsatisfactory. What is a better arrangement?* H.J.S.

Heating water by steam direct is the best and most efficient method in spite of your trouble. It takes a lot of heat to raise the temperature of 130,000 gal. of water from 52 to 78 deg., and it would require about two tons of coal. A 500-sq.ft. boiler would have to run about 20 hr. at 100 per cent rating to supply this much heat.

Part of the trouble is evidently due to using too small a pipe. It is not the pressure that counts, but the amount of steam. A ¾-in. pipe will not deliver the full rating of the boiler at 100 lb. pressure. Why not try a 1½-in. pipe?

If this heating is noisy you can remedy it by installing a special type of nozzle made for water heating, and arranged to circulate the water rapidly past the steam.

Power of Compound Engine Referred to Low-Pressure Cylinder—*Having a 16 and 32x42-in. compound engine running 100 r.p.m., with 60 lb. mean effective pressure in the high-pressure cylinder and 14 lb. mean effective pressure in the low-pressure cylinder, how is the power computed by referring the mean effective pressure of both cylinders to the low-pressure cylinder?* J.M.C.

With the same stroke in each cylinder, the cylinder ratio will be the area of 16 in. diameter to the area of 32 in. diameter, and as the areas of circles are to each other as the squares of their diameters, the cylinder ratio will be as 16×16 to 32×32, or 1 to 4. Hence each pound mean effective pressure of the high-pressure cylinder would be equivalent to $\frac{1}{4}$ lb. mean effective pressure in the low-pressure cylinder, and with the mean effective pressure of both cylinders referred to the low-pressure sylinder the power developed would be

$$\left(\frac{60}{4} + 14\right) \times (32 \times 32 \times 0.7854) \times \frac{42}{12} \times \frac{100 \times 2}{33{,}000} = 494.73 \text{ i.hp.}$$

Load on an Induction Motor—*A 100-hp. 3-phase, 60-cycle, 440-volt induction motor is connected to a line shaft. The full-load current of the motor, given on the nameplate, is 110 amp. The only instrument that I have is a portable ammeter. With no load, except the line shaft and the connected belting, the motor took 63 amp., and with full load the ammeter read 135 amp. I do not know the power factor or the efficiency. Is there a way of calculating the horsepower load on the motor?* J.Z.

There is no way of calculating the power input to the motor from the ammeter reading unless the volts and the power factor are known. It is not necessary in this case to make any calculations, as the ammeter reading, with full-load on the motor, exceeds the nameplate current given on the machine. This shows the machine is overloaded and if its temperature is excessive the load should be reduced to bring it within the capacity of the motor. There is no definite relation between the current input to an induction motor and the power output. At light loads the power factor is low, and the current input for a unit power output is higher than at near full load, when the power factor is fairly high. An induction motor operating at no load will take about 30 to 35 per cent of full-load current. These values however, will vary with the speed of the motor, being higher for slow-speed motors and lower for high-speed machines.

It may be that you can obtain the characteristic curves of the motor from the manufacturer of the machine. With these available, for a given ammeter reading you can read the motor's efficiency, power factor, and power input off the curves. Where only a check on the load current is required, an ammeter serves the purpose nicely, as it will show when the full-load current is being exceeded. For a power survey of the load on the system a watt meter and a power-factor meter should be used. Recording types of instruments are preferable. If the voltage conditions and the current loads of each phase are desired they must be obtained with voltmeters and ammeters.

Setting Valves of Duplex Pumps—*Why is the valve of each side of a Duplex steam pump driven by the second piston, and how are the valves set?* R. P.

The ordinary duplex direct-acting steam pump, such as is used for boiler feed or house service, employs two simple *D* slide valves. However, unlike the steam engine *D* valve, those of the pump have no steam or exhaust lap. It is necessary to omit these laps to prevent the pump from stopping should the two valves cover all the ports at the same time.

By measuring the length of the *D* valve the exact distance between the outside edge of the two steam ports and the exhaust cavity in the valve, the exact distance between the two edges of the exhaust part, it will be found that there is but one point in the valve travel when the valve covers both the steam ports. And there is sufficient steam leakage by the edge of the steam valve to cause it to admit enough steam to move the piston.

The valve is driven by a rock shaft connected to the spool on the rod of the other cylinder, and a similar arrangement drives the valve of the other steam valve.

To set the steam valves, remove the steam chest cover and then shift the pump pistons and rods until both of the rock shafts are vertical. The steam pistons are now in the center of their strokes.

Next, place the valves so that they cover both of the steam ports, and adjust the lock nuts on the valve stem until there is equal clearance on both sides of the valve. On some pumps there are no lock nuts, but merely a threaded block which fits into a recess in the top of the valve. In this design the block is turned on the valve stem until the clearances at each end are equal. If adjustable nuts are used, it is necessary to know just how much clearance to put between the valve and the nuts. Ordinarily the "lost motion" should equal 25 per cent of the valve travel, or, in other words, the clearance between each nut and valve should be $\frac{1}{8}$ of the valve travel.

If with this amount of lost motion the pump does not make a full stroke, the lost motion should be increased. Lost motion will alter the pump speed, slowing it up, as the lost motion reduces the valve travel and consequently the rate at which the steam enters the cylinders.

On large pumps there is a lost motion link outside the valve chest, so that the piston stroke and speed can be altered by changing the lost motion.

Total Heat in a Pound of Steam—*One of my fellow engineers claims that the column in steam tables giving the "total heat" actually does not give the total heat in a pound of steam. Is this true?* B. M.

The "total heat column" gives the total heat that has been added to a pound of steam to bring it to a specific state of pressure and temperature from an original state of water at 32 deg. F. The heat absorbed by the fluid is used to perform two duties: To provide the internal energy necessary to overcome intermolecular attraction and to provide the energy necessary to make room for increased volume of the fluid. The latter energy is expended upon the surrounding medium. For example, if the boiler is connected to a steam engine, the water, as it turns into steam, increases its volume, and, to provide the necessary space, forces the piston to move. At all times the steam contains its intrinsic energy for a given state, but the external, or volume-increasing, energy has been lost in doing external work. So the total heat column always gives a value greater than the heat actually in the steam.

But if we reverse the process and have the piston compress steam and force it into a condenser, external work is done on the steam and the external work is transferred through the steam to the condensing water. Or if the engine compresses the steam back into the boiler and, by cooling water, the steam is then condensed back to feed water, this total heat that must be removed is equal to that given in the steam table column and is exactly equal to the total heat that was added to the feed water to form steam at the original pressure and temperature. Consequently, for practical engineering problems the total heat value should be used, as we are interested not in the actual heat in the steam but in the heat that has been added or rejected when the fluid goes from one state to another.

A Question for Our Readers

WE HAVE a cooling pond with mud bottom and banks, and are having trouble with crawfish boring holes in the bottom and banks. What is a remedy for this trouble? Will a chemical, such as chlorine, added to the water kill the crawfish? J. MacC.

Suitable answers from readers will be paid for and published in the Aug. 5 number

Combined Heat and Power Supply in Industrial Plants

In this abstract of a paper delivered at the recent World Power Conference in Berlin, Mr. Ryan shows the advantages of high pressure and its difficulties. He points to growing co-operation between utilities and industrial plants, to better use of waste heat, and to a new field for Diesel engines.

▼

By W. F. RYAN

IN 1925 I discussed the advantages of higher steam pressures in the industrial plant[1]. It was pointed out that whereas the efficiency of a central station was increased only 10 per cent, by increasing boiler pressure from 400 lb. to 1,200 lb., a similar increase in pressure would more than double the effectiveness of non-condensing prime movers supplying high-back-pressure steam to a manufacturing process. The mechanical difficulties of generating and using very high steam pressures had been solved by the public utilities, and our industries were not slow to appreciate the value of this new development in their own plants. Early in 1929 an American technical magazine[2] was able to list 141 industrial plants using steam pressures above 300 lb. Only two had been installed prior to 1924.

The majority of high pressure, non-condensing plants have proved thoroughly reliable in operation. The turbine wheels are small in diameter, and the blades are short, so that in spite of high speed, usually 3,600 r.p.m., the stresses are low, and the availability factor high. Many have never been taken out of service except for routine inspection and repairs.

Thanks to the pioneer work of central station designers and operators, no unusual difficulties have been experienced with steam generating equipment, except when feed-water conditions have been unfavorable. In many industries the process steam cannot be returned as condensate, and the use of treated water has proved troublesome, if not impracticable, in the higher-pressure plants.

This condition may compel the use of an intervening evaporator condenser between the prime mover and the process-steam supply, or it may compel the use of extensive evaporators for make-up water. The former increases the capital cost of the plant, and reduces the yield of byproduct power; the latter increases capital cost and operating expense. Even under these unfavorable conditions, however, a high-back-pressure non-condensing power plant will ordinarily produce electric power at a cost that is gratifying to the owner.

The cost of electric power in a high-back-pressure industrial plant is largely a matter of bookkeeping, because of the lack of uniformity in dividing fixed charges and operating expense between the two items of electric power and process steam. In the larger plants, the cost should not exceed five mills per kilowatt-hour.

Co-operation of Public Utilities

While the advantages of private power generation in high-pressure prime movers are obvious, and are being convincingly demonstrated, few industries are capable of developing this idea to its economic limit. The big power-consuming industries, for example, automobile manufacture, are not great consumers of process steam; frequently a seasonal heating load is the only steam demand. On the other hand, the big consumers of exhaust steam, oil refineries, salt works, alkali plants, etc., are relatively small consumers of electric power. Moreover, there is frequently a regrettable lack of synchronism between the demands for these two forms of energy.

The full economic value of the high-back-pressure prime mover can be developed only by co-operation between industries and public utilities for the combined production of process steam and electric power. Co-operation of this type has been discussed academically for some time, but it is only now beginning to find practical application. This step is the outstanding development in the field of industrial power and heat supply today.

To discover the potential savings from the co-operative effort of industries and public utilities, and to illustrate these savings by diagrams, is a simple engineering problem. To put the idea into practice, and to convert these potential savings into cash, is a business problem which is not simple at all.

There is a deep-seated, and well-founded, reluctance on both sides to invade what, up till now, they have each considered the domain of the other.

However, our electric power companies have neglected few opportunities to extend their service, or to reduce their costs. Our manufacturers have been equally diligent in reducing production costs.

These heat units, and the dollars they represent, will not be allowed to roll into the atmosphere and into the ocean forever.

The first requirement for the success of such a co-operative enterprise is that the advantages must be equitably divided between the two parties. If the plant is owned and operated by the manufacturer, the utility must be assured of the continuity of the power supply. If, on the other hand, the utility owns and operates the plant, the manufacturer must be assured of the reliability of his steam supply. If a plant is built under joint ownership, there must be a just division of costs between the two services. All three of these plans are in use in this country today. All require mutual confidence, good engineering, and intelligent management, and each party must have a sympathetic understanding of the problems of the other.

Another field in which public utilities and the industries may profitably co-operate is in the better utilization of waste fuel. There are some industrial plants which can supply their entire heat and power requirements with combustible waste from their manufacturing operations. To improve the efficiency of power generation or heat utilization in such plants would only create an unmarketable surplus of waste fuel. If surplus power could be sold at a figure advantageous to both producer and purchaser, then it would pay to use efficient apparatus and prevent unnecessary waste.

The pioneering is now being done by the more enterprising managements, and we may look for a rapid and widespread development of co-operation between public utilities and the large steam-using industries.

The Internal-Combustion Engine in the Industrial Plant

The Diesel engine has been used for many years as a prime mover in industrial plants where the cost of oil fuel and other conditions have made its use economical. Industries which require process steam have generally found it cheaper to use steam-driven prime movers, but even in this case oil and

[1] "The Value of Higher Steam Pressures in the Industrial Plant. W. F. Ryan, *Transactions* A.S.M.E., Vol. 47 (1925) P. 779.

[2] See *Power*, May 28, 1929.

gas engines have been effectively used in conjunction with steam boilers. Boiler feed water has been used as a cooling medium in the cylinder jackets, and in some cases the heat in the exhaust gas has also been utilized for preheating feed water.

Very recently, a number of Diesel engines have been installed to perfect the heat balance of industrial plants. Attention has been called to the lack of synchronism between steam and power demand in the average industrial plant. In the past it has been common practice to design the electric power plant to meet average conditions, and to blow exhaust steam to the atmosphere whenever the demand for power was out of proportion to the demand for exhaust steam. Condensing units, to take care of this condition, are impracticable in plants which lack an abundant supply of cold water. A purchased-power connection is also frequently undesirable, on account of the high cost of furnishing current for intermittent use; also, the hazards of interconnection make it difficult to secure an exact balance by this method.

In this situation the Diesel engine-generator becomes an effective method of perfecting the balance. All the power that can be generated non-condensing, and without waste of exhaust steam, is obtained from steam prime movers; the deficiency is supplied by the Diesel. The heat saving is obvious; a non-condensing steam engine may reject 20,000 to 40,000 B.t.u. (5,050 to 10,100 kg. cal.) for every kilowatt-hour generated; whereas the heat loss from a Diesel need not exceed 4,500 B.t.u. (1,136 kg. cal.) per kilowatt-hour, even if no attempt is made to recover heat from jacket water or exhaust.

Internal-combustion engines are also commonly used for starting-up service in isolated plants. Where all auxiliaries are motor-driven, as is now common practice, and where electric current is required for fuel supply, which is usually the case in pulverized-coal plants, the boiler cannot be put into operation after a complete shutdown without some auxiliary source of power. A small gasoline-engine-driven generator is usually sufficient for this purpose.

Recovery of Heat From Low-Temperature Waste

For many years the boiler feedwater economizer was in disfavor among American central station designers. It was considered to give more trouble than its heat recovery was worth. When we began to force our boilers to higher outputs, and the temperature of gas from the boiler increased accordingly, the economizer came back into fashion, not only as a desirable feature, but almost as a necessity for an efficient boiler plant.

We may look for a renaissance of the waste-heat boiler in the industrial plant for much the same reason. We are pushing all production apparatus to higher and higher rates of output. As the waste gases get higher in temperature and greater in quantity, the possibilities of heat recovery become correspondingly more attractive. Waste-heat boilers have been developed for high steam pressures. Several have been installed for pressures above 350 lb., and this futher increases the recoverable energy.

Hot gases are also being used directly, or through the medium of an air heater, for drying and for other manufacturing requirements. At the Iron Mountain plant of the Ford Motor Company stack gas from the power plant is used for drying wood. This plant, which utilizes not only the latent heat of the exhaust steam, but also the sensible heat of the stack gases, eliminates the two major losses in the central station. This is the goal for which we should strive in low-temperature ranges. If operated at the highest economical steam pressure, distributing cheap surplus power to less fortunately situated neighbors, such a plant would represent the ideal industrial heat-power cycle.

Forecast

Not many years ago the industrial power engineer spoke contemptuously of his central station brother as a "B.t.u. chaser." The implication was that the central station designer pursued ideals of thermal efficiency without regard for sound economics. In spite of this alleged extravagance, the public utilities have waxed great and prospered. Industry has seen the light. It is chasing a few heat units on its own account, and finding that dollars may be caught in the same net.

The charge was also made that public utilities could be extravagant with impunity, because monopoly assured them of an adequate return on any investment they chose to make. This, of course, was nonsense. In the industrial field the central station is in competition with private generation of power. In the domestic field it is in keen competition for the consumer's dollar. Electric light may now be regarded as a necessity in the American home, but one does not have to have four base plugs in every room, an electric washing machine, an electric ironer, an electric radio, or an electric refrigerator. Still less does everyone need an electric range. Yet all of these luxuries are in quantity production, solely because the electric light industry is successfully meeting competition.

Here again industrial management has caught the idea; it has learned to distinguish between extravagance and financial courage. Industrial executives are now willing to make sound investments in power equipment, and they are finding them gilt-edged investments.

Therefore, we may look for an undiminished acceleration of progress in the industrial power field. More high-pressure plants, and higher-pressure plants, will be built. Public utilities and industries will co-operate to obtain the maximum power yield from process steam; the day may come when we shall reverse our present nomenclature, and call the single-purpose central station an "isolated plant." Industrial power engineers will attack their present low-temperature wastes with more success; they will contribute their share to retard the ever-increasing entropy of the universe. Then, when it seems that there can be no more worlds to conquer, we shall find that we are just beginning to understand our problem.

Burning Characteristics of Various Solid Fuels

INTEREST in smokeless fuels has centered attention on the relative burning characteristics of cokes made by the various high- and low-temperature processes. Recently the Physical Chemistry Section of the Pittsburgh experiment station, United States Bureau of Mines, has published data on the time of burning of small particles of coal, semicoke, beehive coke, and charcoal under controllable conditions of furnace temperature, particle size and oxygen concentration. Work along this line is being continued on somewhat larger particles and on still other fuels.

Through the use of fuel particles weighing 4 milligrams it has been possible to follow the temperature of the particle throughout its burning. The maximum temperature of an individual particle burning in an excess of air at 800 deg. C. is, of course, much below the temperatures obtainable in a fuel bed.

The interesting part of the temperature curve of the burning, however, is the form the curve takes under different conditions. When the air temperature is 800 deg. C. the rate of rise of the particle temperature above the air temperature is so slow and variable that it is nearly impossible to assign a definite point as the "start" of ignition or active burning. Likewise, the point of completion of burning is often prolonged. With air at 1,000 deg. C. the rate of rise and decline of temperature is very rapid. These effects vary with the nature of the fuel, being most pronounced for a material like electrode carbon. Therefore, strict comparisons of the burning times of many fuels by this method at the lower air temperatures are not possible.

It has been suggested that, given a sufficiently high temperature, the rate of burning of various forms of carbon will depend only on the rate at which oxygen can reach the carbon surface. There is some evidence for this from the experimental side. If this is so, as far as the rate of disappearance of the carbon dioxide goes, attention is drawn away from the question of "reactivity" of the carbon in a fuel bed where normally the temperatures are fairly high. The reactivity of the carbon as far as reduction of carbon goes, may still be very important—likewise the nature and disposition of the ash, the form of which differs for various fuels.

A.I.E.E. Convention in Toronto

Features Operating Problems

Vertical synchronous condensers rated at 25,000 kva. operate out of doors. In a modern power station it has been found possible to put three times the capacity in the same space required five years ago. A system of supervisory control has been developed whereby control operation can be performed and meter reading obtained over two wires. Several methods of protecting rotating machines against lightning are suggested.

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AT THE American Institute of Electrical Engineers, summer convention, in Toronto, Ontario, June 23 to 27, a large number of the papers and reports presented dealt with the problems of the operating engineer. One of the papers, by H. A. Ricker, J. R. Dunbar and R. E. Day, described the construction and operation of four outdoor-type vertical shaft synchronous condensers at the Toronto-Leaside transformer station of the Hydro-Electric Power Commission of Ontario. Two of these units are in operation, and the other two will be by the end of this year. These machines are rated at 25,000 kva., zero power factor leading, 13,200 volts, 25 cycles, and operate at 500 revolutions per minute.

These condensers are located at the receiving end of the commission's 220-kv. transmission line from Paugan Falls, on the Gatineau River near Ottawa, to Leaside, Toronto. It was decided that quick-response excitation was necessary to insure proper operation of the condensers in this location. Accordingly, a laminated-frame, direct-connected exciter with a separate constant-voltage pilot exciter were used for each condenser. By this excitation arrangement, it was possible to obtain a calculated speed of response of the main exciter of about 800 volts per second.

Each unit includes the synchronous condenser, the laminated-frame main exciter, and the pilot exciter on one shaft, as indicated in the figure. On what may be termed the ground elevation, the main stator stands on its support. On top of the stator, and supported on a stator frame extension, is mounted a comparatively light eight-armed girder-type bracket for guide bearing support. The thrust bearing is located at the ground elevation and is supported on a girder-type bracket which, in turn, rests on the foundation. Beneath this thrust bearing bracket is the main exciter, the stator of which is supported on another girder-type bracket; the pilot exciter and a speed relay are underslung from the main exciter bracket.

From ground elevation the main stator is incased in a housing suitably arranged for ventilation and for protection from the weather. Apart from the electrically active materials, the unit is fabricated practically throughout of steel plate, bars, and sections.

Complete, the unit weighs approximately 210 tons. The stator frame, with iron and coils, weighs 84½ tons, and the rotor weighs 75 tons. Maximum weight required to be lifted by the crane is 85 tons. Over-all height from the bottom of the speed relay to the top of the housing is 34 ft. Over the housing, the maximum width, exclusive of the ventilating extensions, is 19½ feet.

A spherical-type Kingsbury thrust bearing not only carries the thrust load but also the lower guide bearing. This bearing seems to be particularly applicable to these units. That it occupies a minimum of space and is extremely easy to dismantle in a restricted and difficult position are perhaps the principal points in its favor. It is self-aligning, self-contained, and easily lubricated.

The heat generated in the oil film of this bearing has to be dissipated by external means. In a preliminary study air coolers for the oil, in the passage of the incoming air, were considered. The cost was found to be excessive, so water cooling was resorted to. For a more detailed description of this bearing see the article, "Spherical Thrust Bearing Takes Vertical and Horizontal Loads," *Power*, page 944, June 17.

Because the thrust bearing space is limited, there was not room for the ordinary arrangement of cooling coils in the oil pot. Therefore an external system of oil circulation to the bearing is employed. Oil drained from the bearing is cooled with water circulated in suitable coolers.

To make starting easy, a high-pressure pump is arranged to force oil through a pipe to the center of each thrust bearing shoe. As in similar applications with horizontal journal bearings, the starting torque required is reduced considerably.

The exciter guide bearing is self-lubricated by centrifugal force and is self-cooled, radiating fins being welded to the housing. It is located at a point too low to permit of draining oil from it back into the main lubricating system.

The speed relay, on the bottom end of the exciter shaft, operates centrifugally. It has three functions to perform: To protect the machine against dangerous overspeed, to permit of the application of field current to the condenser during starting, and to cause the air brakes to be applied during the stopping cycle.

The outer housing is large enough for a man to walk around the condenser frame within the cold-air duct, entrance being provided through the vertical wall. The cover is lagged with felt to prevent possible condensation, but this lagging hardly seems necessary.

Normally, air for cooling the unit enters at one side through the housing extension. Here it is filtered before it enters the cold-air housing. From this duct the air is distributed to the top and bottom of the machine, where fans force it between the poles along the air gap and through the ventilating ducts in the laminations. The air is carried around inside the frame which forms the hot-air duct, where it normally exhausts into the atmosphere through the opposite housing extension.

To guard against the possibility of bearing currents, all bearings are insulated. The complete rotor is insulated from the stator, so that a simple test may be applied at any time to determine if the insulation is intact. Tests made after installation indicate that this precaution was not necessary, as the potential taken from the two ends of the shaft was found to be very small.

Each bearing is provided with a thermometer for temperature indication, also with a hand reset thermostat whose contacts close and stop the machine in case the bearing temperature exceeds the thermostat setting.

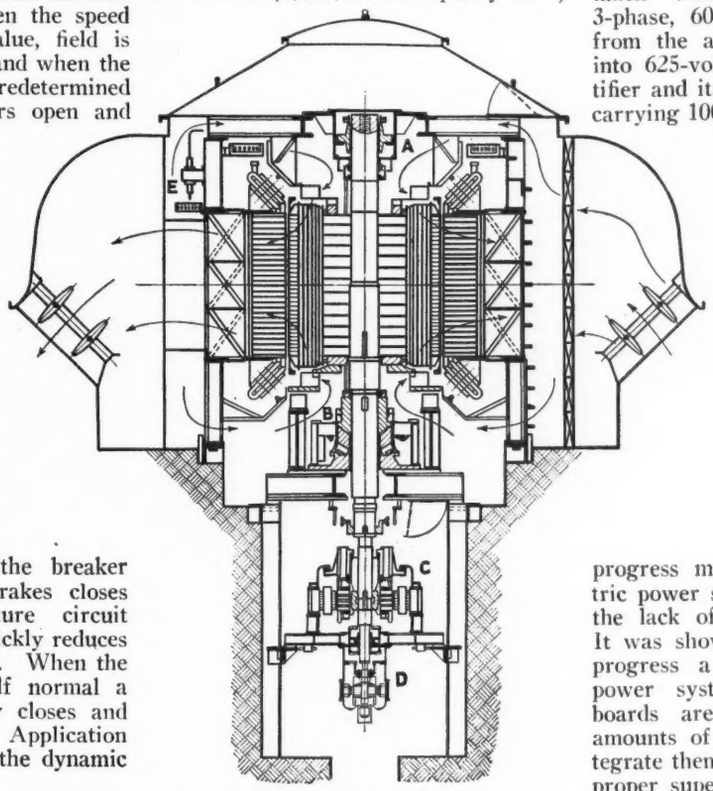
Each machine has two oil-circulating pumps so arranged that if one pump should fail in operation the other will automatically start. In addition, if the oil pressure fails a relay will operate and shut down the machines.

The operation of this station is completely automatic. Starting and stopping and protection are controlled by a number of relays. When the starting button is pushed a master relay closes, provided all conditions are normal.

This relay remains closed only providing the starting operations occur in proper sequence. The master relay's closing causes the high-pressure pump connected to the Kingsbury bearing shoes, as well as one of the oil circulating pumps, to start. When the oil circulation has been built up to the proper value a contact-making gage causes, provided other conditions are normal, the starting and magnetizing breakers to close, and reduced voltage is applied to the condenser, at which time the field will begin to rotate. When the speed has reached a required value, field is built up on the condenser, and when the field current reaches a predetermined value, the starting breakers open and the running breaker closes. At this time the condenser is automatically put under the control of the voltage regulator, it takes its share of the load, and the high-pressure pump stops.

Pushing the stop button, or the operation of a protective relay, causes the opening of the same master relay used in starting. When this relay opens, the condenser is disconnected, the oil circulating pump stops and the field breaker opens. Upon the opening of the condenser's field circuit, the breaker controlling the dynamic brakes closes the main exciter armature circuit through a resistor and it quickly reduces the speed of the whole unit. When the speed decreases to one-half normal a contact on the speed relay closes and the air brakes are applied. Application of the air brakes removes the dynamic braking.

The best condition for starting the Leaside condensers is with a field current of about full-load value using open-circuit transition. Tests show that the best results are obtained with the 26.2 per cent starting tap on an auto-transformer.



CROSS-SECTION THROUGH VERTICAL SYNCHRONOUS CONDENSER

A—Upper guide bearing. B—Spherical combination Kingsbury thrust and guide bearing. C—Main exciter. D—Pilot exciter. E—Current transformers

DESIGN and operating characteristics of the East River generating station of the New York Edison Company were given in a paper by C. B. Grady, W. H. Lawrence, and R. H. Tapscott. The New York Edison and affiliated companies' power system has a total generating capacity of 1,917,000 kw., and in 1929 the peak load was 1,225,200 kw. The first two units in the East River plant were 60,000-kw. machines. A third unit of 160,000-kw. capacity has been installed.

When it was decided to make the first extension of this station, it was found that turbine builders were prepared to supply single turbine generators having a capacity of 160,000 kw. each at a considerably lower cost per kilowatt than for the 60,000-kw. units in the original installation. It was then decided that in the extension of this station the same number of units as originally planned would be installed, but that they would have nearly three times the capacity of the original machines. The manner in which this has been accomplished is as follows:

Turbine-generators 1 and 2 (60,000-kw. capacity each) occupy 0.083 sq.ft. per kilowatt capacity, while turbine-generator 4 (160,000-kw. capacity) occupies 0.0452 sq.ft. per kw. capacity. Boilers 1 to 6 (250,000-lb. steam capacity each) occupy 9.2 sq.ft. and 1,140 cu.ft. per 1,000 lb. steam capacity. Boilers 7 to 9 (1,000,000-lb. capacity each) occupy 4.5 sq.ft. and 625 cu.ft. per 1,000 lb. steam capacity. Similarly, the electrical galleries for generators 1 and 2 require 0.48 sq.ft. of floor area and 7.39 cu.ft. per kilowatt capacity, whereas similar equipment for generator 4 occupies 0.215 sq.ft. of floor area and 3.92 cubic feet.

THE "Development of a Two-Wire Supervisory Control System With Remote Metering" was described in a paper by R. J. Wensley and W. M. Donovan. With this system any operation can be performed which does not require the simultaneous use of more than two wires between the local and the remote stations. A circuit breaker or similar switching device may be closed or opened; the voltage of a generator may be raised or lowered; the operation of a voltage regulator may be controlled; the gate opening on a water-wheel generator may be controlled; and many similar functions performed. Indications associated with the various control operations, water level, and machine loadings may be given. Remote metering may also be used in conjunction with this supervisory control equipment, operating over the same pair of wires.

The 1,000-kw. automatic mercury-arc rectifier substation of the Union Railway Company of New York was the subject of a paper by W. E. Gutzwiller and O. Naef. Energy is taken either from the 13,200-volt, 3-phase, 60-cycle station main bus or from the auxiliary bus and converted into 625-volt direct current. The rectifier and its transformer are capable of carrying 100 per cent load continuously; 150 per cent load for two hours; and 200 per cent load for one minute. These ratings are based on a normal rating of 1,000 kw. at 625 volts direct current and on 25 or 60 cycles.

SWITCHBOARDS are a part of power plants and substations that have not been given much attention in the way of improving their design. This was emphasized by Philip Sporn in a paper "Miniature Switchboards." The progress made in the design of electric power systems was contrasted with the lack of progress in switchboards. It was shown that due to this lack of progress a situation confronts many power systems today where switchboards are so large that excessive amounts of space are necessary to integrate them so as to bring them within proper supervisory control of a limited number of operators. A development in miniature switchboards was described, containing all the fundamental requirements of a control switchboard and yet with no greater space than 4 in. of panel width for complete control and supervision of one feeder. Attention was called to installations showing the possibility of developing a switchboard along those lines that will handle 60 feeders and yet bring it within the range and operating control of a single operator.

PROBABLY the largest industrial plant power system in this country is the Monongahela Valley system of the Carnegie Steel Company near Pittsburgh, Pa. This system was described in a paper, "Automatic Power Supply for Steel-Mill Electrification," by Robert J. Harry. Five large plants are tied together by a 44,000-volt transmission system. When this voltage was adopted it was considered to be the highest that could be used with any guarantee of continuous service. Successful operation of these lines has led to the conclusion that higher voltages could be successfully used.

There are five transformer substations in which are installed a total of nine

9,000-kva. three-phase transformers. Three of the substations are the typical outdoor type, and two are of indoor construction. Experience has shown that to prevent rapid deterioration of the transformers' radiators it is necessary to paint them frequently when they are installed near blast furnaces.

AN AUTOMATIC SUBSTATION has been installed in a new structural mill which contains three 1,500-kw. motor-generators. The motors are standard synchronous machines arranged for compensator starting. The reason for making this substation automatic was to reduce the operating cost. It was also considered safer to depend on automatic features, that are continually on the alert and ready at all times to do their assigned duty, rather than upon an operator who may or may not be on the scene when trouble occurs to the equipment.

L. B. Chubbuck in a paper "Metal-Clad Gum-Filled Switch-gear" described the construction and advantages of this type of equipment compared with the usual forms of open- or cell-type gear, and enumerated the following points:

1. All live parts are fully inclosed usual forms of open or cell-type in grounded metal casing, and are interlocked to prevent operating mistakes.

2. Much less space is required and building expense is saved, particularly as compared with masonry-cell structures. With metal-clad gear, the instrument panels are often mounted directly on the structure.

3. Bus insulators, busses and other parts are immersed in gum and are free from dust, moisture, smoke, vermin, or secondary short circuits due to ionized gas. The insulated bus, mounted on micarta supports under gum, provides a high factor of insulation, and during voltage surges the time lag under gum is much greater than with air. The gum provides a mechanical buffer for the busses and other parts under short-circuit conditions, and the use of non-brittle micarta supports in a substantial metal structure gives a high factor against mechanical failure.

4. Maintenance should be a minimum, for reasons previously given and because of easy removal and replacement of the oil circuit breakers for inspection.

5. As metal-clad gear is factory built and shipped completely wired, a minimum time and expense is required for installation. Where the instrument and control panels are mounted on the structure no small-wire conduits are necessary in floors and other parts of the buildings.

AN OSCILLOGRAPHIC STUDY of the transient oscillation in rotating machine windings was presented by E. W. Boehne, in a paper entitled "Voltage Oscillation in Armature Windings Under Lightning Impulses." From the facts made known by the investigation the conclusions were reached, regarding protective equipment, that the lightning arrester is the most effective device now available for the protection of machine windings. However, it limits only the magnitude of the wave which enters the machine winding and cannot control the oscillations within the winding. It does not affect the front of the wave below the breakdown voltage value of the arrester.

Neutral impedance when used can be made of thyrite, and can effectively be an open neutral during normal operation and yet afford the necessary additional protection in case of a dangerous surge.

Capacitors in parallel with the lightning arresters afford adequate protection for the insulation between turns of machine windings. They also provide protection for the insulation to ground of machine windings by reducing internal oscillations in cases where the neutral is open. In this respect they may even be designed to eliminate the oscillations in short open neutral windings.

The principles of shielding which have proved successful in protecting transformers may also be applied to generator windings. For the adequate protection of large units connected directly to the line and with the neutral open, some protection in addition to lightning arresters is necessary to insure that the internal voltages to ground will not exceed the arrester voltage and to adequately protect the insulation between turns.

SEVERAL METHODS of protecting rotating machines against lightning when connected to overhead circuits were given by F. D. Fielder and Edward Beck in a paper "Effects of Lightning Voltages on Rotating Machines and Methods of Protecting Against Them." A common practice of doing this, where lightning conditions are severe, is to interpose an insulating transformer protected by lightning arresters between the machine and the overhead line.

Combinations of inductance, capacity, and arresters connected in the machine circuits may be used. This provides effective protection at a moderate cost, and in the authors' opinion is to be preferred to the use of capacity without inductance.

A method equally effective is to shunt parts of the winding by capacities with arresters applied to the machine terminals. It may require some modification of machine design to bring out the leads to the condensers.

Another effective method is to shunt parts of the winding, and the arresters, if so applied, should have the lowest possible rating. The previously described methods are to be preferred from the standpoint of protection. A length of cable may be interposed between the machine and the overhead line. Short lengths of cable will exert little beneficial effect; long ones may; other methods are preferable. The machine's windings may be specially shielded with arresters applied to its terminals. This requires more or less sweeping changes in design which at the present time do not appear economically practical.

ANOTHER paper on protecting electrical equipment was that by J. Allen Johnson and Edwin S. Bundy, on "Standards of Insulation and Protections for Transformers." The principal considerations were outlined that determine transmission line insulation on the one hand and transformer insulation on the other, and it was concluded that the former is a service problem requiring special consideration, while transformer insulation is a manufacturing problem requiring a standardized solution. It was the authors' opinion that complete co-ordination of the two seems impossible, indicating the need for protective apparatus between the line and transformers.

Considerations affecting the selection and characteristics of protective measures were discussed and the reasons outlined for believing that at present service experience is a better criterion than research tests upon which to determine the kind of protection to use. Twenty-five years' service experience on the system now controlled by the Buffalo, Niagara & Eastern Power Corporation, with protective gaps similar to those recommended as one of the proposed protective measures, was described, and the conclusion drawn that the use of such gaps under suitable conditions constitutes a satisfactory protective measure.

A paper, "Present-Day Hydro-Practice in Central Europe," was presented by A. V. Karpov, an abstract of which will appear in the next number of *Power*.

Spraying Insulators in Service

IN THE first World Power Conference report (on page 983 of the June 24 number of *Power*) a photograph illustrated dust removal by sprays, in a switching station of the Southern California Edison Company. This photograph, which was taken from the paper presented at the Conference by Professor Robert Sibley, should be further explained.

During the long dry season alkali salts from the soil gradually form a coating on the insulators of many West Coast switching stations. This is hard to remove. By producing artificial rainstorms for a few minutes each day it is possible to remove this coating before it has acquired any great thickness and before it becomes hard.

Experiments were made in an attempt to produce drops large enough to loosen and wash off the dust and at the same time keep the volume of water down to a point where surface conductivity would not be increased to the danger point. The problem, it was stated by Professor Sibley, has been successfully solved, and sprays of the sort indicated are now in use on the Pacific Coast.

The Engineer's Bookshelf

Higher Thermodynamics

LES SOURCES DE L'ÉNERGIE CALORIFIQUE ET LE CHAUFFAGE INDUSTRIEL. *By Émilio Damour. Published as part of the "Encyclopédie de Science Chimique Appliquée" under direction of C. Chabrié, by Librairie Polytechnique Ch. Beranger, Paris, France; 1930. Volume 1, Cloth, 6½x9½ in.; 477 pages, 129 figures.*

UNDER THE TITLE "Sources of Thermal Energy and Industrial Heating" Émilio Damour presents in the first volume a treatise on gaseous combustion comprising the scientific basis of the technique, the theory of furnaces with direct firing, and of gas-fired furnaces. The last chapters are devoted to operation and control of combustion.

Like all technical works by French authors the volume is written in a classical style, assuming that the readers are thoroughly conversant with calculus, physical chemistry, and higher thermodynamics. Treatment of the difficult subject is enlightening, but by no means easy reading.

Experts in metallurgical furnaces, gas generators, glass, ceramic ovens, incinerators, etc., will find rich material in it. Gas generation and recuperation of heat are dealt with fully, but it is unfortunate that the problem of heat transfer has not been treated so exhaustively, especially radiation.

The clear broad viewpoint of the author on combustion in general, condensed into crisp mathematical language will be a pleasant surprise to American combustion engineers, who are mostly supplied with literature of practical operation.

N. ARTSAY.

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"To Merge or Not to Merge"

OPERATING ASPECTS OF INDUSTRIAL MERGERS. *By William R. Basset. Published by Harper & Brothers, 49 East 33d St., New York City; 1930. Cloth, 5½x8 in.; 205 pages. Price, $3.*

THERE is so much generalized controversy these days on the subject of industrial mergers that it is most satisfying to run across a book which presents without bias basic information on the factors influencing consolidations in industry. The present volume is such a book, and Mr. Basset is to be congratulated on the fine piece of work he has done in writing it.

Starting with reasons for merging, or not merging, whichever the case may be, the author describes the various types of industrial and merchandising mergers. Following this he presents practical and definite data on the production, distribution, and administration economies effected through consolidation when such consolidation is soundly conceived.

"Putting a Merger Together" is the title of the next chapter, which is without doubt one of the most valuable parts of the book from an executive or engineering point of view. Here the author carefully traces the steps by which each integral part of a merger is made to dove-tail in with all the others.

In a provocative chapter on the trend of the merger movement, Mr. Basset gives a logical idea of what may be expected in the future. He writes:

"Whether in manufacturing, in retailing, or in public service, it is evident that merging of mergers is a natural tendency and one which is well under way. Where it may end no one can safely say. Of one thing we may be sure: The economic reasons for merging are so sound, so compelling, in fact, that left alone by the courts and by Congress it is quite certain that merging will continue to be done. It seems all but certain that 25 years hence we shall see fewer concerns doing business—but they will be far larger than even the largest of today."

Clearly expressed in non-technical language, the book should prove valuable alike to the trained executive looking for practical information, and the layman striving for a better comprehension of the vast complexities of consolidations. And it is highly readable.

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Coal and Iron Waterway

THE FUTURE MOVEMENT OF IRON ORE AND COAL IN RELATION TO THE ST. LAWRENCE WATERWAY. *By Fayette S. Warner. Published by the University of Pennsylvania Press, 1930. Cloth, 6x9 in.; 195 pages; 51 illustrations, maps and graphs, 52 tables. Price, $3.*

NOTWITHSTANDING opposition to the development of the St. Lawrence River, it has great economic possibilities, both as a source of power and a means of transportation. Succeeding years will see this river become not only part of the greatest inland deep waterway system in the world but also one of the largest sources of power generated by hydro-electric plants. This river is capable of developing 5,000,000 hp., and millions more horsepower can be developed in the same locality from water power. Besides, it is a connecting link between the ocean and the Great Lakes, with an annual traffic movement of about 125,000,000 tons. Its possibilities are so vast that economic laws will eventually force them to be utilized to their fullest extent.

A masterly study showing the future of the St. Lawrence River in relation to the coal and iron ore supplies of the world, this book is confined primarily to the probable movement of iron ore and coal, and indicates that the movement of a large volume of mineral tonnage over this waterway may be anticipated. A large tonnage of foreign iron ore may be expected to move into the Lake Erie district to supplement the Lake Superior ores now being used, and at the same time a large tonnage of coal may be expected to move into export as a haul-back for the ships which bring in foreign iron ore.

The 103 maps, graphs, and tables present a vast collection of data on practically every phase of iron-ore and coal distribution and its movement in the world. The facts presented make the book a valuable reference for those interested in the development of the St. Lawrence River, and in the iron and coal industry.

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Brief Reviews

DUST PROBLEMS. Published by Dust Recovery, Inc., 15 Park Row, New York City. Paper, 68 pages, illustrated; free.—An analysis of the dust-collecting problem in general with specific solutions applied to representative cases.

BOILER WATER IMPURITIES AND THEIR CONTROL BY THE CONTINUOUS BLOWDOWN SYSTEM. By Roy O. Henszey. Published by the Henszey De-Concentrator Company, Watertown, Wis. Paper, 28 pages; free.—A convenient reference book for the operating engineer, which should be of material assistance in helping him dispose of boiler-water problems.

AN ELECTRICAL METHOD FOR THE DETERMINATION OF THE DEW-POINT OF FLUE GASES. By Henry Fraser Johnstone. Circular No. 20 of the engineering experiment station, University of Illinois, Urbana, Ill.; free.—Description of an electrical device, based on the conductivity of a glass surface, for determining the dew-point of flue gases.

STANDARDS OF THE DIESEL ENGINE MANUFACTURERS' ASSOCIATION. Published by the D.E.M.A., 30 Church St., New York City. Paper, 57 pages, illustrated; free.—Definition of terms and practices to promote a more intelligent agreement between the buyer and seller.

THE FLOW OF AIR THROUGH CIRCULAR ORIFICES WITH ROUNDED APPROACH. By Joseph A. Polson, Joseph G. Lowther, and Benjamin J. Wilson. Bulletin No. 207 of the engineering experiment station, University of Illinois, Urbana, Ill. Paper, 52 pages, illustrated; price, 30 cents.—Results of a study of the flow of air through orifices, and the determination of coefficients for Fliegner's formula.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Device for Lifting Elevator Cars When Shortening Cables

ONE of the most difficult parts of the job of renewing or shortening elevator rope is lifting the cars. A common way of doing this is with two chain falls and rigging connected to the overhead work. To simplify this work the Evans Elevator Equalizer Company, Chanin Building, New York City, has developed the car-lifting equipment shown in the figure. It was devised originally by the company for use when installing its Evans equalizers on the hoisting cables of traction elevators. The equipment has now been placed on the market, to meet the many requests from elevator engineers and building managers who have seen it used.

Two hangers *H* connect under the car's crosshead. At the top end of the hangers is an equalizing bar with a threaded nut in the center. The nuts are free to move to any position around horizontal trunions and allow the load to be equally distributed on the hangers. The top part of the equipment has a flat beam in which are U-bolts for clamping the cables to it. A hanger at each end terminates in an equalizing bar with a nut in the center. The car is lifted by threaded rods *R* that connect to the top and bottom parts of the hanger. The lift rods have a fixed nut at their centers, with a ratchet wrench for easy operation.

When the hoisting ropes are to be shortened the car is run to any convenient location in the hoistway and the lifting device put into place under the crosshead and attached to ropes as in the figure. Then by turning the threaded rods the car is lifted the desired amount. The ropes can be cut and re-socketed, the whole operation being done from the top of the car. When the car has to be lifted to replace the ropes the hanger is supported from the overhead beams.

The greatest labor saving is made when shortening the ropes. In this work the hanger eliminates the necessity of blocking the counterweights and of using any overhead rigging.

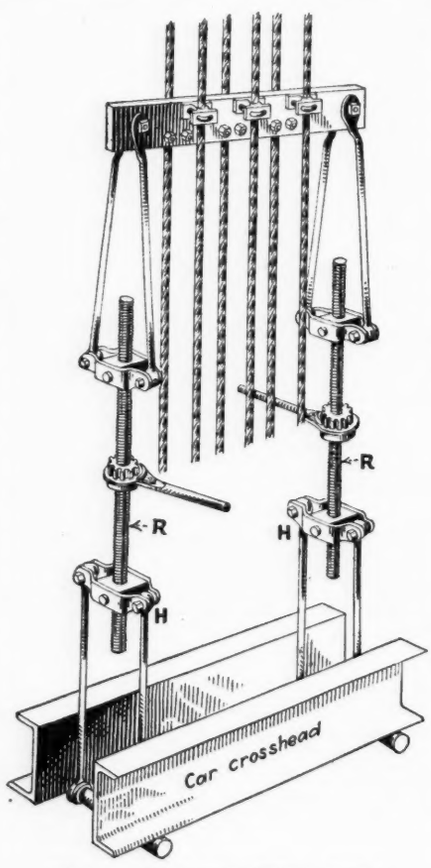
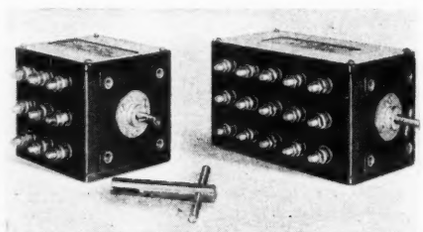


Diagram of the car-lifting device

Meter and Relay Test Switch

A NEW test switch designed to facilitate checking of meters and relays has been introduced by the Meter Devices Company, 3115 Tuscarawas St., Canton, Ohio. It consists of a one-piece Bakelite case, with removable top and bottom covers, in which is mounted a rotor on a square steel shaft. The shaft extends through the front of the case and is rotated by a specially designed key. Phosphor-bronze contact jaws are mounted on both sides of the case, and specially designed knife blade assemblies complete the mechanism.

The switches are made in four-, six-, eight- and ten-pole combinations for switch board mounting. The switch itself is mounted on the rear



Two types of "Roto-Test" switch

of the board and the faceplate appears only on the front. An interlocking feature provided by the faceplate prevents the key from being withdrawn after test until the switch is restored to service position. Space occupied on the switchboard is 4x4 in. for each switch, and five holes in the board are all that are necessary for mounting.

The switch can be applied to any type of switchboard and used with all standard makes of instruments, meters, and relays. Overcurrent relays may be tested in any one phase without disturbing the others.

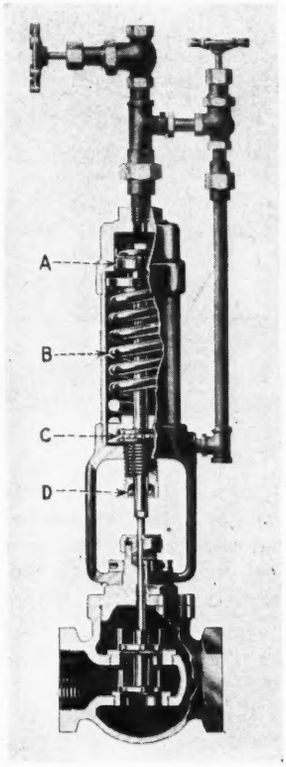
Ball-Bearing Piston-Type Pump Governor

EMPLOYMENT of an improved design of valve and application of ball bearings at two points to eliminate friction are outstanding features of the Neilan ball-bearing piston-type pump governor No. 200 illustrated.

In the improved valve, designated "Seatringuide," the guides are integral with the seat ring instead of being on the disk, as is the usual practice. This design, it is claimed, reduces wire-drawing to a minimum

and increases the capacity by reducing the flow turbulence. The valve is closed by the delivery line pressure connected above the piston *A*, which operates against the tension of the spring *B*. The spring is carried at the lower end on the ball-thrust bearing *C*. Employment of this anti-friction bearing permits the spring-adjusting nut to turn freely without disturbing the spring setting. The stem is also fitted with a ball bearing guide, as at *D*.

Sizes from ½ to 4 in. are available. Sizes up to 2 in. have bodies of hard bronze with screwed ends. Cast



Cut-away view showing application of ball bearings

nickel-iron bodies with flanged ends are furnished in 2 in. and larger. All governors are regularly supplied equipped with valve plugs and seat rings milled from solid Monel metal bar stock, but bronze or stainless steel may be had. All valve stem and guide ball bearings are made of non-corrosive, stainless steel. The valve is put out by Neilan, Schumacher & Company, 641 Santa Fe Ave., Los Angeles, Calif.

Bending Machines for Tubing and Pipe

THE accompanying illustrations show an improved line of hand- and motor-operated bending machines now being put out by the

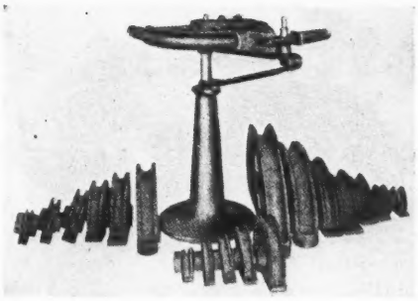


Fig. 1—Hand-operated machine for conduit and pipe up to 2 in. diameter

American Pipe Bending Machine Company, Inc., 37 Pearl St., Boston, Mass.

Type A-30, hand-operated, shown in Fig. 1, is designed to handle all sizes of conduits from ½ to 2 in., inclusive. Three sets of bending forms and cast-steel shoes are available (one set being supplied with each machine). No. 1 set is for standard-radius conduit bends, No. 2 for cold-pipe bending, and No. 3 for hot-pipe bending. With No. 3 ½-in. pipe can be bent to 1½ in. radius, and 2-in. pipe to 6 in. radius.

A thin gage tubing bender (Type V) is shown in the upper view, Fig. 2. This machine is designed to handle all sizes of steel, brass, and copper tubing (annealed) without heating or filling. It is claimed by the manufacturer that practically any bend, such as 45, 90 and 180 deg., offsets, compounds, etc., can be made

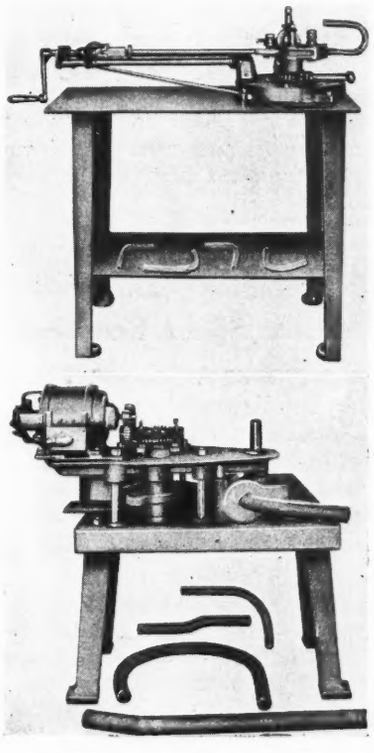


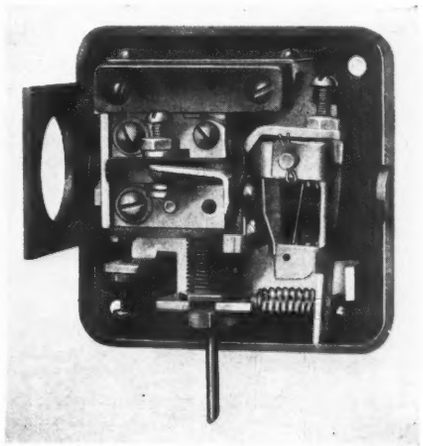
Fig. 2—Hand operated tubing bender and motor operated machine for pipe

without any change in the wall of the tubing. The dimensions of the machine are 42 in. long, 42 in. high, and 20 in. wide.

In the lower view, Fig. 2, is shown Type H-29, motor-operated, for cold-bending all sizes of steel, wrought-iron brass and copper pipe of standard gage from ¾ to 2 in., inclusive. Dimensions of the machine are 52 in. long 52 in. wide, and 25 in. high. It is equipped with a 2-hp. motor and the weight is 1,550 pounds.

New Thermostat to Control Industrial Heating Units

A NEW THERMOSTAT recently announced by the General Electric Company, Schenectady,



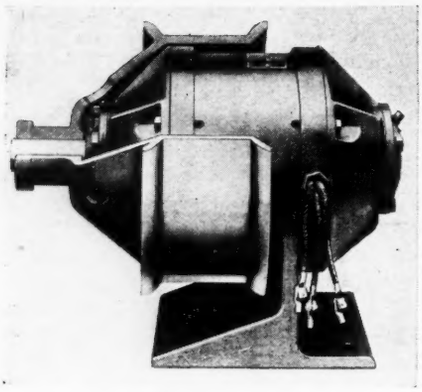
Thermostat with cover removed

N. Y., is suitable for use with oil burners and various industrial heating units. Operating ranges are 60 to 200 deg., 150 to 300 deg., and 250 to 400 deg. F. It has an operating differential of 5 per cent of maximum temperature range.

The unit is mounted on a pressed-steel base which has two mounting holes and a bracket with an opening for a ¾-in. conduit. All steel parts are cadmium-plated to resist corrosion, and silver contacts are used A ⅛-in. capillary tube is sealed to the bellows on the switch end and has a bulb on the immersion end.

Motor With Special Design of Support and Pulley

ALTHOUGH designed primarily for certain types of conveying in steel mills, the motor illustrated, with a pulley-type roller keyed to the shaft rotating around the body of the motor, is adaptable to other uses in the industrial field, as rollers or



Pulley rotates around motor body

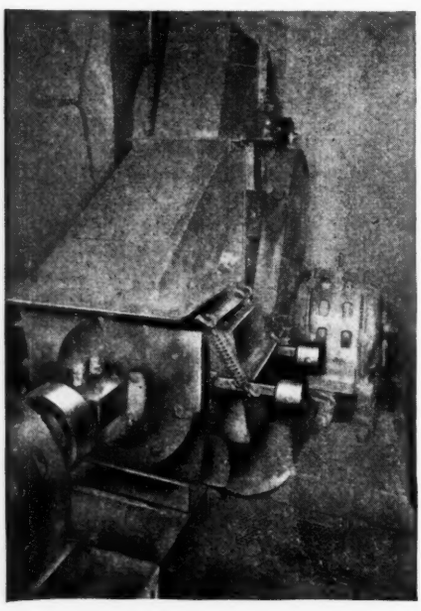
pulleys of various shapes can be used.

The motor is fully inclosed and is provided with asbestos and mica insulation to withstand high temperatures. Large ball bearings are employed. Space requirements are reduced to a minimum by having the roller or pulley rotate around the body of the motor, as shown. Use of a single heavy welded steel support is another feature of the motor, which is put out by the Reliance Electric & Engineering Company, 1042 Ivanhoe Road, Cleveland, Ohio.

Two-Sector Coal Crusher

HIGH CAPACITY, low power consumption, and small size per unit of output are among the claims made for the two-sector type coal crusher now being put out by the A. A. Crusher & Pulverizer Company, 136 Liberty St., New York City.

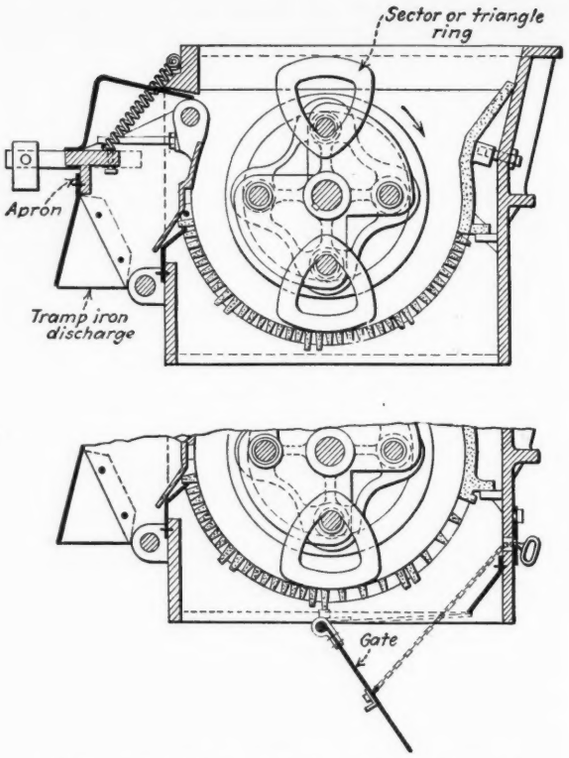
The machine, which is of all-steel construction, has unusually low overall height for a given capacity, the type Y unit illustrated, with a capacity of 120 tons an hour, being only 25½ in. high. The crushing element consists of two rows of triangular-shaped sectors mounted diametrically opposite on a spider, which, in turn, is mounted on an oversize shaft carried in long sleeve bearings. The crushing sectors are made of manganese steel, and by virtue of their design wear uniformly, because the heavier side becomes the crushing surface automatically.



Crusher has low overall height

The unit is equipped with a spring-loaded apron which permits the tramp iron contained in the coal to be discharged without damage to the machine. Units are available with a number of different grinding arrangements, such as with full-grate grizzly, as shown in the top view; with gate for producing two sizes of product, as shown in the lower view; or with coal sampler attached and with bypass for passing slack coal.

Another important claim made by the manufacturer for the two-sector type of grinding element is the elimination of fan action, with consequent lessening of the dust nuisance. The crushers are made in a number of sizes, ranging in capacities from 10 to 800 tons an hour on bituminous coal.



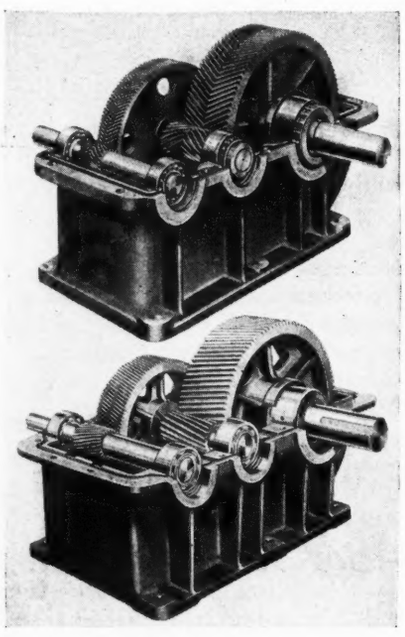
Sections through crusher and crushing elements

Herringbone- and Helical-Gear Speed Reducers

A NEW LINE of speed reducers (designated IXL Titans) in both single and double reductions and in herringbone- and helical-gear types, DB and DX, respectively, has been brought out by Foote Brothers Gear & Machine Company, 111 North Canal St., Chicago, Ill.

With the exception of the gears used, the two types are practically identical. Ribs are provided at each bearing to insure rigidity, and the inside of the upper case is also ribbed as a precaution against longitudinal vibration. Grooves are provided for the return of oil from the bearings to the bottom of the case. Splash lubrication is standard. Ball bearings are used on the high-speed shaft and roller bearings on the low.

One of the important features of the new line is that the ratio is standard and applies to all sizes for each type of reduction. On the single-reduction units, types SB and SX, the ratios range from 2.87 to 9.9 On the double-reduction units, types DB and DX, illustrated, the ratios range from 9.95 to 96.2.



Open view of double-reduction units

NEWS of the FIELD

Spot News

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ONCE MORE *disaster has thwarted Professor Georges Claude's attempt to extract energy from the difference in temperature between the surface and the bottom of the Gulf Stream near Cuba. On June 25 a 5,905-ft. section of 6½-ft. corrugated steel tubing, which was being lowered into the ocean, broke loose from its moorings and was destroyed. The tube was valued at more than $1,000,000, and three months of hard work by Professor Claude and 100 laborers had been devoted to its completion.*

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PRESIDENT HOOVER *on June 24 signed the Couzens bill providing for the reorganization of the Federal Power Commission. Immediately afterward he was flooded with suggestions concerning appointments to the new commission. Nominations of the five commissioners had not been forwarded to the Senate at this writing, but the President indicated that he would make the appointments at an early date.*

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ICELAND *is planning to use its numerous springs of boiling and warm water as a source of heat and power for its capitol, Rekjavik, according to a report of Consul General North Winship, made public by the Department of Commerce. A pumping plant will be constructed underground near Wash Springs, and the natural hot water will be pumped to the city. On the basis of a water temperature of 40 deg. C., it is expected that the system will produce approximately 80,000,000 calories during each 24-hr. period.*

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RAPID DEVELOPMENT *of the steam locomotive, particularly in the last few years when more improvements have been made than ever before designed to bring about increased power and efficiency without increasing proportionately the consumption of fuel, has delayed the necessity for electrification of railroads, according to a report submitted June 25 to the eleventh annual convention of the Mechanical Division, American Railway Association.*

Suit Filed to Block Boulder Project

COURT ACTION to block the Boulder Dam project was taken on June 24 when an injunction suit was filed in the Supreme Court of the District of Columbia by Fred T. Colter as trustee of the Arizona Highline Reclamation Association. A court order is requested for the purpose of restraining the Secretary of the Interior from taking any action under the contracts with the City of Los Angeles and the Metropolitan Water District of California.

The petition submitted to the court claims that exploitation of water resources of the Colorado by the Government constitutes a confiscation of Arizona's property without due process of law which is a violation of the Constitution. It is stated that Arizona has made plans for the development of the power resources of the Colorado on its own behalf, and that the Federal Power Commission has approved these plans. The Southern California Edison company was not mentioned in the suit.

Despite opposition from Arizona, the section of the second deficiency bill appropriating $10,660,000 for commencement of work on the Boulder Dam project, has been left in the measure as it goes to the Senate. In the House, Representative Douglas of Arizona, made an unsuccessful attempt to raise a point of order against the appropriation. Senator Hayden of Arizona endeavored to have the Boulder Dam clause stricken from the bill in the Senate appropriations committee. The committee decided, however, to report the measure to the Senate with the Boulder Dam section intact.

New England States N.A.P.E. Holds Annual Convention

The eighteenth annual convention and exhibition of the New England States Association of the National Association of Power Engineers was held at the State Armory in Salem, Mass., June 19 to 21. Seventy-five accredited delegates were in attendance, and nearly 75 manufacturers had booths at the exhibit of power equipment in the main drill hall of the armory.

Opening the convention on Thursday evening, Ralph E. Dutton, chairman of the local convention committee, explained the purposes and activities of the organization. The welcome of Mayor George J. Bates, of Salem, was fittingly responded to by Arthur F. Ford, New England States president, and National President James McDevitt. H. P. Gifford, president of the Salem Five Cents Savings Bank, gave an interesting review of the business cycles of which this country has been subject to and predicted a speedy recovery from the present depression.

The Friday morning session was opened with an invocation by the Rev. Carl Heath Kopf, who also delivered a graceful layman's appreciation of the part which power plays in modern civilization and the service rendered by the association and its members. This was followed by short addresses by F. R. Low, editor emeritus of *Power*, and by National President McDevitt.

In the afternoon William J. Reynolds, chairman of the board of trustees delivered a stirring address urging the members to greater interest and more active participation in the educational work of the association.

Election of officers resulted in the choice of Charles E. McLean of Worcester as president; Arthur F. Ford, of East Boston as past president; Arthur A. Austin of Springfield as vice-president; Karl B. Powers of Cambridge as secretary; and Walter H. Damon of Springfield as treasurer.

Entertainment features included a trip to Pequot Mills and a theater party for the ladies, and a stag party at the Hawthorne Hotel Friday evening, at which Joe McKenna of Jenkins Brothers and Bobby Jones of Garratt Callahan Company entertained. On Saturday an outing was held at Salem Willows.

To Install 35,000-Kw. Unit in Riverside Station

Announcement of the installation by Northern States Power Company of 35,000 kw. of additional generating capacity at the Riverside steam-electric station in Minneapolis, Minn., has just been made by the Byllesby Engineering and Management Corporation. The installation will consist of one 35,000-kw. turbine, with necessary condensing equipment, boilers, and other auxiliaries.

Four 6,000-sq.ft., 250-lb. pressure boilers will be removed, and the boiler room will be extended to provide space for three boilers, each with a capacity of 200,000 lb. of steam per hour, to be installed in connection with the new turbine, as well as space for three similar boilers to be installed when necessity

for additional capacity arises in the future. The present equipment in Riverside station operates at a normal pressure of 250 lb., while the new equipment will be designed for operation at 400 lb., to take advantage of the superior economies to be obtained by the use of the higher pressure.

Work on the substructure of the power house addition is scheduled to start Nov. 1, 1930, during low water stages on the river, and the project is scheduled for completion in the fall of 1931. Upon completion of this installation, the Riverside station will have a capacity of 107,000 kw., and with other construction now in progress, Northern States Power Company will have total installed generating capacity of 436,060 kilowatts.

W. S. Lee Elected President at A.I.E.E. Meeting

William S. Lee, consulting engineer, and president of the W. S. Lee Engineering Corporation, Charlotte, N. C., was elected president of the American Institute of Electrical Engineers for the year beginning Aug. 1, 1930, it was announced at the annual meeting of the Institute held at Toronto, Ont., June 23, during the annual summer convention of the Institute. The other officers elected were: vice-presidents—I. E. Moultrop, Boston, Mass.; H. P. Charlesworth, New York, N. Y.; T. N. Lacy, Detroit, Mich.; G. C. Shaad, Lawrence, Kan.;

Underwood & Underwood

William S. Lee

H. V. Carpenter, Pullman, Wash.; directors—A. B. Cooper, Toronto, Ont.; A. E. Knowlton, New York, N. Y.; R. H. Tapscott, New York, N. Y.; national treasurer, George A. Hamilton, Elizabeth, N. J. (re-elected).

The annual report of the board of directors, presented at the meeting, showed a total membership on April 30, 1930, of 18,003. In addition to three national conventions and two district meetings, 1,489 meetings were held during the year by the local organizations in the principal cities and educational institutions in the United States, Canada, and Mexico.

Crane Company Celebrates 75th Anniversary

Simultaneously, in widely scattered places throughout the world, 85,000 people will picnic July 3 to celebrate the 75th anniversary of the founding of the Crane Company and its growth from a one-man shop to a worldwide organization.

The chief celebration is in Chicago, where approximately 1,000 veteran employees and officials of the company are gathered to help nearly 10,000 employees in Chicago observe the day. At the same time, a score will be celebrating the event in Rangoon, Burma; and others in Paris and London, and Colombo, Ceylon; in Brazil and Mexico and Cuba; in hundreds of cities of the United States and Canada. The Chicago celebration began on June 29 and will continue to July 4, with the picnic on July 3 as the climax.

The event thus celebrated is a characteristic American industrial romance. In 1855, a young man of 23 migrated from New Jersey to Chicago. There, in a corner of his uncle's lumber yard, he built a little shack with his own hands. In it on July 4, 1855, he made his own first castings. The man was R. T. Crane, founder of Crane company. Now, the business that he founded employs more than 20,000 people. It has nine factories, covering 375 acres of land in the United States, Canada, Great Britain, and France, and it manufactures more than 33,000 items.

New York State Forms Economic Council

Alarmed because of the relative halt in the economic development of New York State, and anxious to seek and apply adequate remedies, leaders in the state's business and professional fields have just announced the creation of the New York State Economic Council.

The urgency of the need for such an organization first found opportunity for expression at the New York State-Wide Economic Congress held in September, 1929, which then authorized the Committee of Twenty-Five to study the entire situation and prepare adequate measures for dealing with it.

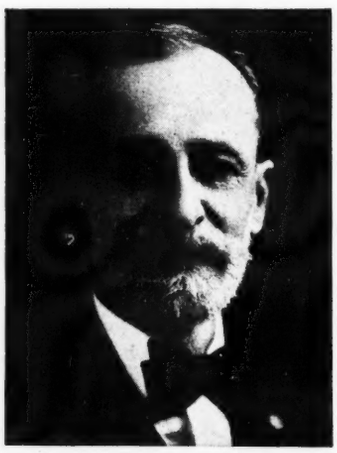
Since then the committee has visited several important cities of the state, studied industrial and business conditions at first hand, and conferred with men prominent in business, industry and finance. These surveys and much deliberation convinced the committee that a permanent organization was needed, so as to make possible broader representation from all interested districts and a general extension of the work.

The New York council proposes to take a keen interest in all legislative activities, investigate taxes, public expenditures, and all those factors that have contributed to the decline in industrial development throughout the state.

John W. Hill, Waterworks Engineer, Dies

John Wilmuth Hill, nationally known hydraulic and mechanical engineer, died June 22 at his home in Cincinnati, Ohio, as the result of a paralytic stroke. He was born in Covington, Ky., on Oct. 10, 1848.

Mr. Hill was noted for the design and construction of municipal waterworks in many of the country's largest cities, including Cincinnati, Philadelphia, Washington, Baltimore and Buffalo. His



John W. Hill

work in steam engineering, in which profession he made several inventions, gained him national recognition, and in 1883 he compiled a pocket manual for steam engineers.

After conducting test trials of automatic cut-off steam engines and other power exhibits for an award of premiums by the Cincinnati Industrial Exposition in 1874-'75, he invented and patented a system of surface condensation for pumping engines adopted to utilize the water pumped under control and regulation for condensing purposes.

Mr. Hill was appointed chairman of a commission in 1896 to survey and develop plans for the extension and betterment of the Cincinnati waterworks, including filtration of the Ohio River water supply. In 1906 he was appointed superintendent and chief engineer.

In 1898 he became consulting and chief engineer for the Philadelphia Water Plant and following its completion in 1904 he continued in this work, serving in the same capacity in Newport, Ky.; Hamilton, Ohio, and Knoxville, Tenn.

Mr. Hill was a life member of the American Society of Civil Engineers and the American Waterworks Association, a member of the Franklin Institute and American Power and Hydraulic Association.

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MILES W. BIRKETT, vice-president and general manager, The Washington Water Power Company, Spokane, died June 13 from complications following an operation for appendicitis.

Personals

E. F. BAILEY, of Salt Lake City, was elected president of the Utah section of the National Association of Power Engineers at the recent annual meeting of the organization held in Salt Lake City. Other officers elected were: LEON ASHER, vice-president; M. L. LEE, recording secretary; C. E. CHAPMAN, corresponding secretary; J. P. QUIGLEY, finance, and W. D. HAWKES, trustee, all of Salt Lake City. G. L. ASHER was elected a life member in appreciation of his activities in the association.

WILLIAM MONROE WHITE, noted hydraulic engineer, recently received the first honorary degree of doctor of science ever conferred by Tulane University. A graduate of that institution, Mr. White is chief engineer and manager of the Allis-Chalmers Manufacturing Company.

THOMAS A. EDISON was presented on June 20 with a gold medal typifying the gratitude and affection of electrical engineers and scientists of Argentine and commemorating of the golden jubilee of his incandescent lamp, by WILLIAM A. REECE of Buenos Aires, president of the General Electric, S. A., of Argentine.

EDWIN GRUHL and JAMES B. BLACK, vice-presidents of the North American Company, with headquarters in New York, and GUY C. EARL, president of the Great Western Power Company of California, were elected to the directorate of the Pacific Gas & Electric Company at a meeting of the board held June 18.

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Business Notes

STEPHENS-ADAMSON MANUFACTURING COMPANY, Aurora, Ill., announces the removal of its New York sales and engineering office to Room 1360, 50 Church Street.

CHICAGO PNEUMATIC TOOL COMPANY, New York City, announces the election of W. L. Lewis, vice-president, secretary and treasurer to succeed J. G. Grimshaw, secretary and treasurer, who resigned. Mr. Lewis was formerly assistant comptroller of the Bethlehem Steel Corporation.

DAVID V. FENNESSY, consulting power engineer, of El Paso, Texas, announces the removal of his offices from their former location in the Mills Building to 1108 Bassett Tower, El Paso, Texas.

NEILAN, SCHUMACHER & COMPANY, Los Angeles, Calif., will in the future be known as NEILAN COMPANY, LTD., A. F. Schumacher, formerly vice-president, having retired from the business.

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Coming Conventions

American Society of Mechanical Engineers. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

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Trade Catalogs

BAFFLES—Under the title "How BECO Baffles Modernize Old and New Water Tube Boilers," a bulletin has recently been published by the Boiler Engineering Company, 24 Commerce St., Newark, N. J. Numerous illustrations show how to baffle all types of water-tube, horizontal and bent-tube boilers.

STEAM HEATING—The improved Webster Type "R" system of steam heating is described in a new catalog published by the Warren Webster Company, Camden, N. J.

DECONCENTRATORS—In a 12-page bulletin the Henszey De-concentrator Company, of Watertown, Wis., tells how automatic control of boiler-water concentration is accomplished, explains the Henszey de-concentrator, discusses scale prevention and priming, and describes special equipment for regulating, cooling and measuring the blowoff.

PIPE THREADING DEVICES—In a 92-page, profusely illustrated catalog the Toledo Pipe Threading Machine Company, 1425 Summit St., Toledo, Ohio, describes its line of pipe-threading devices, including pipe cutters, reamers, vises, portable work benches, boring tools, drives, and pipe machines.

PUMP PRIMING—Bulletin 501 of Barrett, Haentjens & Company, Hazleton, Pa., deals with centrifugal pump priming, 505 with submerged pumps, 509 with pumps primed with foot valves, 512 with ejector priming, 515 with priming by hand, 520 with vacuum-pump priming, 522 with power primers, 601 with arrangement of intake piping and dimensions of pipe fittings. These are presented in a booklet entitled "Centrifugal Pump Accessories."

MARKETING—The Policyholders Service Bureau of the Metropolitan Life Insurance Company, One Madison Ave., New York City, has just finished a widespread survey of the special forms of co-operation undertaken in marketing by independent business enterprises outside the scope of regular trade association activities. The results of this investigation are set forth in a report, entitled "Co-operative Marketing Activities in Business," published by the Bureau.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.25 @ $2.50
Kanawha	Cincinnati	1.15 @ 1.35
Smokeless	Cincinnati	1.85 @ 2.00
Smokeless	Chicago	1.75 @ 2.00
West Kentucky	Chicago	.85 @ 1.30
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	1.10 @ 1.25
Big Seam	Birmingham	1.60 @ 1.75
Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$2.90 @ $3.00
Barley	New York	1.15 @ 1.50

FUEL OIL

New York—June 26, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6@6.25c. per gal.

St. Louis—June 18, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.420 per bbl., or 42 gal.; 26@28 deg., $1.495 per bbl.; 28@30 deg., $1.595 per bbl.; 30@32 deg. $1.645 per bbl.; 32@36 deg., gas oil, 4.01c. per gal.; 38@40 deg., distillate, 4.98c. per gal.

Pittsburgh—June 18, f.o.b. local refinery, 30@34 deg., fuel oil, 3.5c.@3.75c. per gal.; 36@40 deg., 3.5c.@4.25c.

Philadelphia — June 23, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — June 17, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—June 14, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 75@80c. per bbl.; 26@30 deg., 85@90c. per bbl.; 30@32 deg., $0.95@$1.00 per bbl.

Boston—June 23, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.32c. per gal.; 28@32 deg., 5c. per gal.

Dallas—June 21, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—Central Holding Co. Inc., 110 North Alameda St., awarded contract for the construction of a 12 story hotel at Sunset Blvd. and Crescent Heights Blvd.; also 13 story hotel at La Brea Ave. and Hollywood Blvd. to H. W. Baum Co., Central Bldg. Estimated cost $1,800,000 and $620,000 respectively. Steam heating system, elevators, etc. will be installed.

Calif., Los Angeles—Serrano Corp., Henry de Roulet Co., 3778 Wilshire Blvd., awarded contract for the construction of a 13 story office and stores building at Wilshire Blvd. and Western Ave., to William Simpson Construction Co., 1007 Architects Bldg. Estimated cost $1,250,000. Steam heating system, elevators, etc., will be installed.

Calif., Modesto—City awarded contract for a 2,000 g.p.m. deep well turbine pump and motor in connection with waterworks to Byron-Jackson Pump Mfg. Co., Berkeley.

Conn., Bridgeport—United Illuminating Co., 1119 Broad St., awarded contract for foundation for turbine and other electrical equipment for power generation to R. E. Hurley Construction Co., 120 Pequonnock St. Estimated cost $95,000.

Conn., Mansfield—State Bd. of Finance, Hartford, awarded contract for the construction of dormitories, power plant and laundry at State Training School here to Manchester Construction Co. $228,916.

Conn., West Hartford—St. Thomas Seminary, Bloomfield Rd., awarded contract for extension to convent including boiler house to W. F. O'Neil, 983 Main St., Hartford. Estimated cost to exceed $150,000.

Idaho, Silver City—Trade Dollar Consolidated Mining Co., c/o W. White, Supt., is having plans prepared for the construction of a hydro-electric plant at Swan Falls power site on Snake River. Estimated cost $250,000. A. J. Wiley, Boise, is engineer.

Kan., Topeka—Kansas Power & Light Co., Tecumseh, will build a 1 story, 53 x 72 ft. power sub-station at 12th and Winter Sts. Estimated cost $50,000 including equipment. Work will be done by separate contracts.

Mass., North Andover—Meadow Brook Laundry, is receiving bids for the construction of a power plant including equipment. Estimated cost $25,000. H. Petzold, 712 Bay State Bldg., is engineer.

Mass., North Reading — Dept. of Public Health, will receive bids until July 2 for alterations to and equipment for power house at State Sanitorium. Estimated cost $40,000. R. D. Kimball Co., 6 Beacon St., Boston, is engineer.

Mich., Flint—St. Joseph's Hospital, will receive bids until July 8 for the construction of a 6 story hospital, nurses' home, power house, etc. Estimated cost $300,000. D. A. Bohlen & Son, Indianapolis, Ind., are architects.

Mich., Plainwell — Michigan Paper Co., awarded contract for the construction of a 50 x 108 ft. power plant to D. F. Miller Co., Kalamazoo. Estimated cost $300,000. Three 600 hp. boilers and equipment will be installed.

Mich., Ypsilanti—State Administrative Board, Lansing, awarded contract for the construction of a hospital including power house, tunnels, etc. to Otto Misch Co., 159 East Columbia St., Detroit. Estimated cost $1,308,886.

Minn., Ely—Pickands-Mather Co., 700 Sellwood Bldg., Duluth, will receive bids in July for the construction of an engine house here. Estimated cost $50,000. Private plans.

Minn., St. Paul—First National Bank, E. A. Tyler, Merchants National Bank Bldg., awarded contract for the construction of a 32 story bank and office building at 4th and Minnesota Sts. to P. Steenberg Construction Co., 914 Builders Exchange Bldg. Steam heating system, etc. will be installed.

N. J., Northfield—Bd. of Chosen Freeholders, Guarantee Trust Bldg., Atlantic City, awarded contract for the construction of a 1 story power and heating plant at Atlantic Co. Asylum to P. T. Haunum, Atlantic City. Estimated cost $40,000. Contract let for steam boilers and settings.

N. Y., New York—New York Central R.R., 466 Lexington Ave., had plans prepared for the construction of a 1 story boiler house at 127 Marble Hill Ave. Estimated cost $40,000. F. B. Freeman, is chief engineer.

N. C., Charlotte—Johnson C. Smith University, H. L. McCrory, Pres., raising $400,000 for the construction of administration building, classroom building, for theological school and central heating plant.

Pa., Pittsburgh—City Ice & Fuel Co., H. D. Norwal, Pres., 6611 Euclid Ave., Cleveland, O., awarded contract for the construction of a cold storage plant on Pike St., to Blome-Sinek Co., Clark St., Chicago, Ill. Estimated cost $300,000.

Pa., Royersford—City is having plans prepared for the construction of a sanitary sewage system including disposal plant and pumping station. Estimated cost $400,000. Remington, Vosbury & Goff, Camden, N. J., are engineers.

Tenn., Livingston — City plans an election soon to vote $60,000 bonds for improvements to waterworks and distribution systems including pump house, etc. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., are engineers.

Tex., Corsicana—F. N. Drane, plans the construction of a pumping plant to irrigate 2,000 acres of land. Koch & Fowler, Central Bank Bldg., Dallas, are engineers.

Tex., Schertz—U. S. Government, c/o A. W. Parker, Constructing Quartermaster, awarded contract for furnishing equipment and supplies for plumbing and heating units for 117 new buildings at Randolph Field here to C. J. Rich, 637 South Flores St., San Antonio. $246,000.

Utah, Fillmore—City plans the construction of a municipal hydro-electric plant on Chalk Creek. Estimated cost $30,000. C. Callister, is engineer.

Wash., Seattle — Bd. of Public Works, awarded contract for equipment for local substations including thirteen 2,000 kw. transformers to American Brown Boveri Co., 220 9th St. N., $61,945; network protectors to Westinghouse Electric & Mfg. Co., Lloyd Bldg., $21,442.

Ont., Hamilton — Royal Connaught Hotel Co., is having plans prepared for the construction of an 8 to 10 story addition to hotel, including steam heating system, etc. Estimated cost $1,000,000. Hutton & Sauter, 6 James St. S., are architects.

Ont., Hamilton — City awarded contract for electrical equipment and motors to Canadian General Electric Co., 212 King St. E., Toronto, $18,875, also pump to R. Fitzsimmons & Co., 21 Rebecca St., Hamilton, $21,125, in connection with sewage pumping station, 1, 2 and 3 of East Mountain sewage system.

Ont., Lucknow—City, J. Agnew, Clk., plans an election July 7th to vote $65,000 bonds for the construction of a waterworks system, including the installation of two deep wells and pumping plant.

Ont., Ottawa — Dept. of Public Works, N. Desjardins, Secy., will receive bids until July 8 for reconnecting present generators in power house, also alterations and additions to switchboard and construction of pole line at National Research Council, Sussex St.

Equipment Wanted

Boiler—St. Louis, Mo.—Office of Supervising Archt., Treasury Dept., Washington, D. C., will receive bids until July 9 for the installation of new horizontal tubular boiler, etc. in appraisers stores, here.

Pump—Sunnyvale, Calif.—City plans to purchase a 250 g.p.m. deep well pump.

Pumping Equipment—Rockford, Ill.—Sanitary Dist. of Rockford, G. J. Boehland, Pres., will receive bids until July 15 for two 14 and two 22 m.g.p.d. centrifugal pumping units, two hot water circulating pumping units two sump pumps, sludge pumping unit, switchboard, etc. for proposed sewage treatment plant. Former bids rejected.

Pumps—Adams, Neb.—City, R. B. Winter, Clk., will receive bids until July 10 for 80 g.p.m. single stroke pump, 80 g.p.m. double stroke pump and 80 g.p.m. deep well turbine pump and motor for proposed waterworks system. $27,000.

Pumps—Rio Hondo, Tex.—Cameron County Water Improvement Dist. No. 15 c/o S. Finierewing, Rio Grande Life Insurance Bldg., Harlingan, will receive bids until July 10 for pumps, etc. for proposed irrigation work.

Transformers—Seattle, Wash.—Bd. of Public Works, will soon receive new bids for three 4,000 kva. transformers and four 37,000 v. oil circuit breakers for municipal light department. Former bids rejected.

Industrial Projects

Kan., Wichita—Stearman Aircraft Corp., L. Stearman, Pres., 601 East 35th St., is having preliminary plans prepared for the construction of an aircraft factory including boiler room and power plant at South Hillside Rd. Estimated cost $250,000. The Austin Co., 16112 Euclid Ave., Cleveland, O., is architect and engineer.

Mo., Kansas City—Kansas City Barrel Co., awarded contract for the construction of a 1 story, 110 x 200 ft. factory to J. Gier, 410 East 54th St. Estimated cost $100,000.

Mo., St. Louis — Ralston Purina Co., 835 South 8th St., awarded contract for an 8 story, 86 x 125 and 34 x 58 ft. addition to feed mill at 827 South 8th St. to Jones-Hettelsater Construction Co., 600 Mutual Bldg., Kansas City. Estimated cost $300,000.

Mo., Shrewsbury—St. Louis County Gas Co., Webster Groves, awarded contract for the construction of a 1 story, 57 x 61 ft. addition to generator building here to Woermann Construction Co., 1441 Syndicate Trust Bldg., St. Louis.

N. J., Perth Amboy — General Cable Corp., 420 Lexington Ave., New York, N. Y., awarded contract for the construction of two 1 and 2 story, 56 x 85 and 90 x 100 ft. factory buildings here to H. K. Ferguson Co., Hanna Bldg., Cleveland, O. Estimated cost $100,000.

O., Cleveland—W. S. Tyler Co., E. P. Disbro, V. Pres., 3612 Superior Ave., had plans prepared for the construction of a 3 story, 70 x 106 ft. factory at East 36th St. and Superior Ave. Estimated cost $150,000. G. S. Rider Co., Marshall Bldg., is architect.

O., Salem—Salem China Co., plans the construction of a 1 story, 50 x 150 ft. factory including the installation of a tunnel decorating kiln. Estimated total cost $65,000. Private plans.

Pa., Uniontown—Liberty Explosives Corp., J. H. Lytle, Secy., 1406 Clark Bldg., Pittsburgh, will build an explosive plant at Connellsville and Uniontown Highway. Private plans. Work will be done by separate contracts.

R. I., Cranston—Universal Winding Co., had plans prepared for a 3 story, 58 x 161 ft. textile winding plant. Estimated cost $80,000. Private plans.

Tex., Corpus Christi—Houston Oil Co., c/o E. H. Buckner, Pres., Houston, is having preliminary surveys made for the construction of an oil refinery here. Estimated cost $1,000,000. Private plans.

Tex., Waco—Swift & Co., Union Stock Yards, Chicago, Ill., awarded contract for the construction of a packing and cold storage plant here to J. E. Johnson Construction Co., Waco. Estimated total cost $60,000. Most of equipment contracts let.

Va., Amphill—Du Pont Cellaphane Co., 2 Park Ave., New York, N. Y., will build a plant here for the manufacture of cellophane and other textiles made from viscose and nitrocellulose. Estimated cost $2,000,000. Du Pont Engineering Co., Du Pont Bldg., Wilmington, Engrs., are taking bids on separate contracts.

Ont., Brockville — E. I. Phillips Electrical Works Ltd., L. Grant, de Gaspe St., Montreal, Que., Pres. plans addition to plant. Estimated cost $750,000.

Ont., Toronto — Canadian Wirebound Boxes Ltd, 1000 Gerrard St. E., plans the construction of a 1 or 2 story corrugated box factory. Estimated cost $75,000. Engineer not selected.